

Florida Hurricane Proves Value of Building Codes

Survey Shows That Most Damage Occurred Outside Jurisdiction of City Building Departments—Speculative Buildings Suffer—Reinforced Concrete Wins Perfect Record—Performance of Structural Types—Small Unit Buildings Stand if They Are Properly Constructed—Conclusions

ONE of the most definite and at the same time one of the most encouraging reports that have come out of Florida is that a city building code, backed up by even an average city building department, does have a very positive and favorable influence on the quality of building construction.

One frequently hears expressions to the effect that the best building laws in the world are of no avail unless the city council provides an adequate inspection personnel to enforce them. It is true that nearly all city building departments are under-manned and that salary limitations often prevent the employment of the most satisfactory type of field inspector. It is true also that the magnitude of the work and the great number of projects covered by one field inspector make it necessary for him to confine himself to a very hasty inspection on each project. In one large city, for instance, where each field inspector covers from \$4,000,000 to \$5,000,000 worth of permit values each year, the inspection schedule is tuned up to the point where an inspector is allowed an average time of only 20 minutes to a project. Five minutes is the average time required to drive from one job to another. This leaves an average of only 15 minutes of actual time on each project inspected. But, as the superintendent of buildings of that city once said, "a competent field inspector can see a lot of things in fifteen minutes."

It is a matter of common knowledge among building officials that the building inspection department in the

city just referred to is operating at high efficiency and that construction work in that city is of good quality.

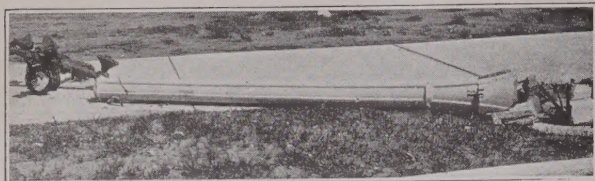
Men familiar with city building inspection have often contended that even if the building department is under-manned, the jerry-builder is afraid to take the chance of being caught, with the probability of having to go to the expense of tearing out a lot of shoddy work. The Florida hurricane has proved conclusively that this is not mere theory, but that it represents the actual situation.

Speculative Building Situation in Florida

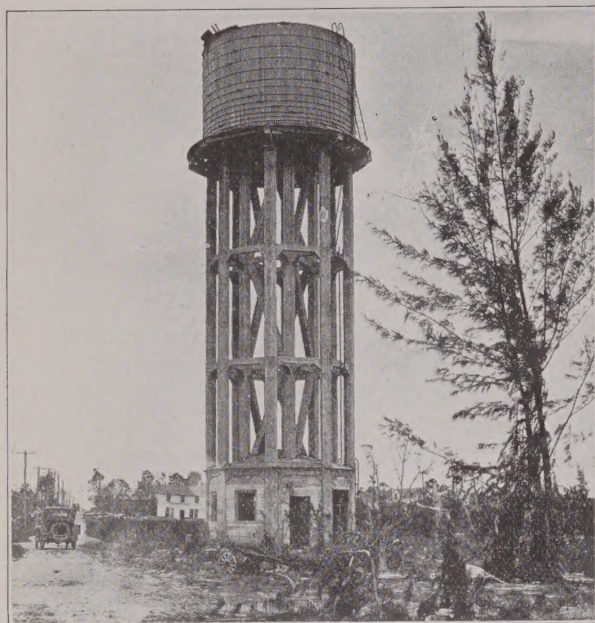
It is well known that the speculative building situation in Florida, outside of cities having building departments, was simply deplorable. The conditions were well described in a private conversation by L. F. Fletcher, City Building Inspector of Orlando, Florida, during the Building Officials' Conference in Columbus, Ohio, in April of this year. Mr. Fletcher said that train loads of hollow clay tile were being shipped into

Florida, of a quality so poor that no city building department would allow their use. They were being put into buildings outside city limits and in small cities not having building departments. Men with any sort of concrete block-making equipment established themselves in tents just outside the limits of the larger cities, used beach sand and very little cement, and made a product that could scarcely be handled without breaking. The speculative jerry-builder, he said, used the product in locations where city building departments had no jurisdiction. All

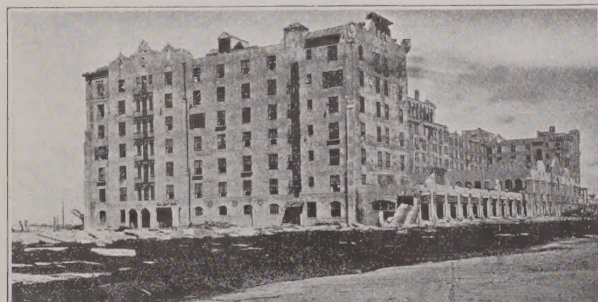
The lessons that may be learned from the destruction of buildings by the Florida hurricane of Sept. 17, 18 and 19, 1926, are becoming quite clearly defined. The mass of evidence is so great that only the most outstanding features can be discussed in this article. The most important lesson that came out of the storm has been taught often before, namely, that good construction will resist violent natural forces and that shoddy construction will fail, regardless of the materials used. It proved again that adequate building laws, properly enforced are effective agencies in the prevention of faulty or dishonest construction and that they insure safety against accident and loss even in times of extreme danger.—The Editors.



A typical failure of improperly designed lighting standards on Los Olas Blvd., Ft. Lauderdale.



Elevated wooden tank on reinforced concrete structure, South Bay Shore Drive, Coconut Grove, Miami. No damage to concrete, but roof of wooden tank blown off, and steel ladder wrecked. Structure absolutely plumb. Note wooden home at rear carried from foundations, and wreck of car in foreground.



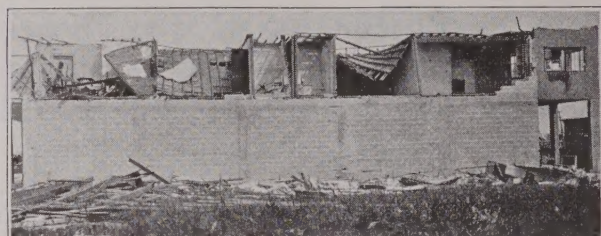
The Hollywood Beach Hotel, Ocean Front, Hollywood. Monolithic concrete structure practically undamaged. Corner damaged from undermining of foundation and repeated impact of washed-up sidewalk slabs. Damage, mostly to furnishings, estimated at \$150,000.



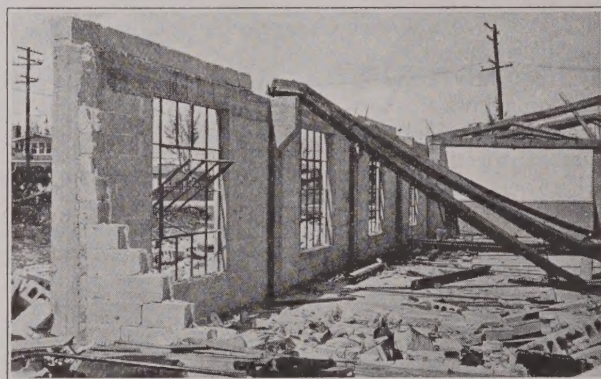
Residence at N. W. corner Sixteenth Ave. and Second St., N. W., Miami. First story wall of 8-inch concrete masonry, second floor of frame. Second story destroyed, first floor intact.



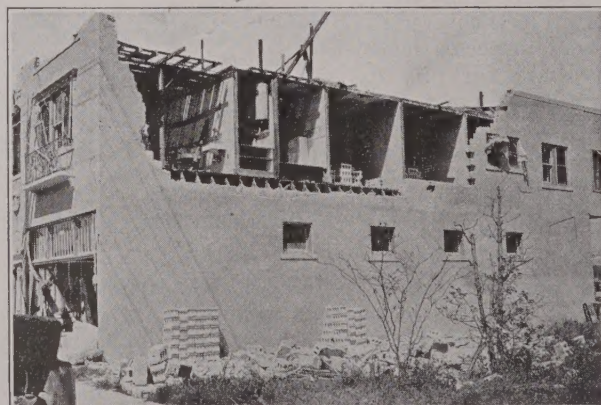
Ocean Drive, Miami Beach, showing general effect of storm on Casino and other business buildings.



Melrose Hardware Store, Hialeah, with reinforced concrete pilasters and frame with 8-inch block wall on first story and unrestrained block wall on second story. The restraining action of the pilasters and frame make a wall withstand wind that will wreck the unrestrained wall.



Garage building, First Ave. and Fourth St., Miami. Eight-inch block wall and reinforced concrete pilasters and frame. Collapse of wood roof trusses caused collapse of one wall. Other walls intact.



The Trail Apartments, 1238 Eighth St., S. W., Miami, looking N. W. An 8-inch concrete block wall without pilasters or other frame. Roof joists and floor joists not tied into wall. Parapet wall blew over, allowing wind to push out rest of wall. Poor mortar indicated by bond failures here and elsewhere.

that city inspectors could do was to look on and hope that a destructive storm would never break. It was not a question, he said, as to what will happen when a severe hurricane occurs, but simply a question as to *when the storm is coming*.

Reinforced Concrete Construction Wins Perfect Record

Probably never before in a major disaster has any type of construction won a record as nearly perfect as the record made by reinforced concrete in the Florida hurricane. In Miami and immediate vicinity there are no less than 15 tall reinforced concrete buildings of the investment type, ranging in height from 10 to 15 stories, and many more of heights below 10 stories. Two of the most notable reinforced concrete structures are the Commodore Hotel in Miami, 14 stories high, and the Fleetwood Hotel in Miami Beach, 15 stories.

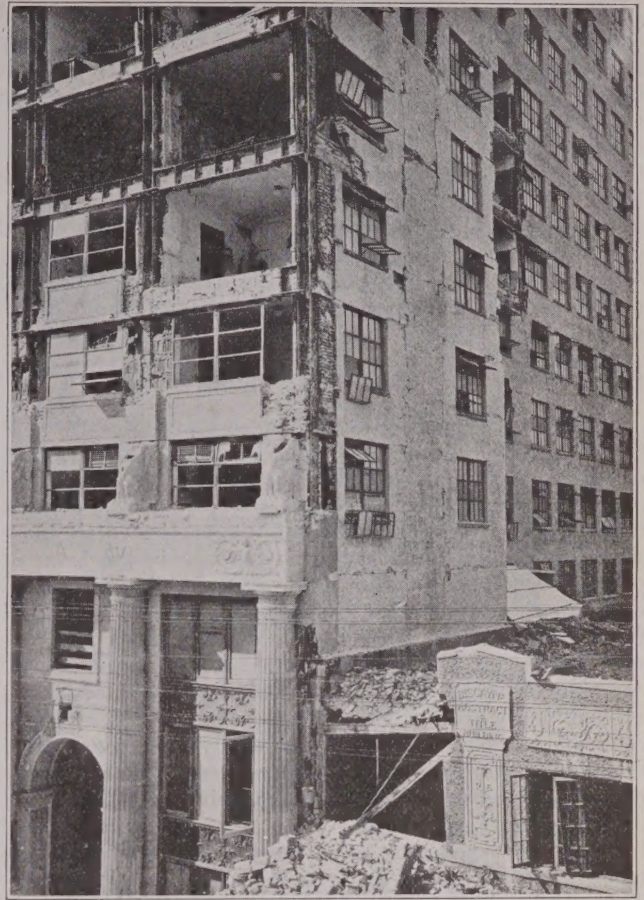
In spite of the large number of reinforced concrete buildings in Miami, the building department of that city has announced that no cracks have been found in any of them, either in exterior walls or interior partitions. The only reinforced concrete structure that suffered any structural damage was the Pancoast Hotel, in Miami Beach, where a corner column was knocked out by the impact of a huge barge which was hurled against it when the sea was 20 feet above its normal level. One bay of the building came down as a result.

It is certain that the excellent record made by reinforced concrete will place that type of construction into the front rank, especially for buildings of the large investment type. In a printed statement that was broadcasted over the entire country, Mayor Romfh, of Miami, gave concrete construction full credit for the small number of lives lost.

Structural Steel Frame Buildings

The record made by buildings with structural steel frames was not so creditable. Two such structures were badly damaged and several others swayed so violently as to cause serious cracking of panel walls and partitions. The two structural steel buildings that failed or were seriously damaged in both instances had their structural frames encased in terra cotta fireproofing, instead of monolithic concrete. As a result, the city building department of Miami will in all probability recommend a provision in the new building code requiring concrete fireproofing for all structural steel frame buildings.

The outstanding structural steel building failure is the Meyer-Kiser Bank Building, a 17-story structure erected during the building boom of 1925. Only a few special



The Meyer-Kiser Building, Miami, was a steel structure with clay tile filler walls. The wind permanently deflected the skeleton and shook out the masonry. The building has been condemned.

investigators have been permitted to enter it, but it is believed to be a total loss. From the fourth to the eleventh floors the front wall was completely shattered, the panel walls having been blown out and all fireproofing broken away from columns and girders. Practically all the east and west partitions have either been destroyed or badly cracked, and the wainscoting in the corridors is likewise damaged or destroyed. In the front wall the 24-inch girders have remained straight and horizontal, while the 12-inch and 14-inch columns are bent sharply just above and below the girders. The connection angles are broken or distorted.

The Meyer-Kiser Building leans westward at its south



The Thatcher residence (left) and Newmeyer residence (right) on the South Bay Shore, Miami. Fair concrete masonry construction. Damage caused by water rising to second story elevation and rotary dredge battering against the wall, breaching the masonry in three places and wrecking a porch at the left.

front, this distortion beginning at the fourth floor and extending to the eleventh floor level. At the eleventh floor it is out of plumb about two feet; but at this point it bends back again nearly into the vertical position. The rear end of the building has an opposite lean of about 8 inches, with no localized distortion in the structural frame, but with some cracking in the lower part of the wall.

The Miami Realty Board Building is extensively cracked in the exterior walls and interior partitions in the lower four or five stories, but the structural frame appears to be plumb and the extent of the damage has not been determined.

Effect of Swaying Structural Frames

There is no question that the swaying of structural frames in tall buildings has much to do with the breaking of exterior panel walls and windows and the cracking of partitions and wainscoting. This is indicated from the fact that several tall steel frame buildings other than those seriously damaged suffered some damage in the form of plaster cracks; but in not a single instance did such cracks occur in a building with a reinforced concrete structural frame. Perhaps the most notable demonstration was that supplied by the Commodore Hotel, a 14-story reinforced concrete building, in which not even the windows were broken to any great extent. The absence of cracking in the reinforced concrete buildings can easily be accounted for from the greater rigidity of the concrete frame as compared with the steel frame. In the opinion of the Miami city building inspector a structural steel frame encased in monolithic concrete will produce a building with a rigidity approximating that of a reinforced concrete frame. This opinion is based on common sense as well as an observation of actual results in Miami. It is therefore not surprising that the city building department is contemplating a building code provision requiring steel frames to be encased in concrete.

Clay Brick Construction Negligible

Interests representing the clay brick industry have flooded the country with propaganda intended to prove that clay brick construction resisted the hurricane. As a matter of fact there is virtually no brick construction in that section of Florida. With common clay brick selling around \$28 per thousand, little of it was used during the building boom of recent years, and the total quantity in Florida is too small to justify any conclusions either favorable or unfavorable.

Concrete Block and Clay Tile Construction

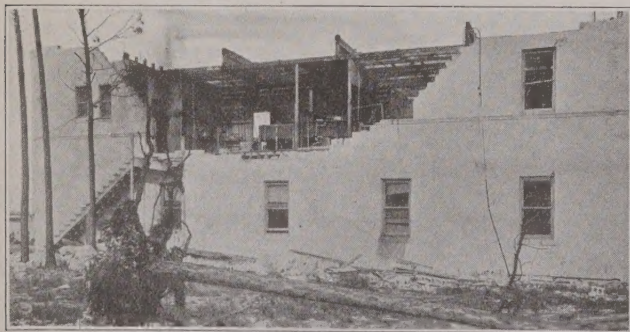
It is in concrete block and clay tile construction that

the value of a reasonably modern building code, enforced by even an inadequate inspection force, is most clearly emphasized.

In Coral Gables, to cite a single example, the building code used, insofar as it affects concrete block construction, follows closely the recommendations of the Department of Commerce Building Code Committee in their "Recommended Minimum Requirements for Masonry Wall Construction." Out of 2,000 concrete masonry buildings in that municipality, only four or five suffered major damage. On the other hand, in outlying sections and outside of municipalities that have building inspection departments much concrete block and hollow clay tile construction was destroyed. But even with the poor quality of individual units used in those sections, mention of which has previously been made, the greater part of the damage occurred through faulty construction, rather than because of the quality of the masonry units. The failures were due to improper laying up of the masonry, poor quality of mortar, thin lower walls, lack of pilaster supports, and absence of anchorage of floors and roofs. Floor joists in many instances were placed on walls with considerably less than 4 inches of bearing and with no anchorage whatever. Roofs were not anchored at the top of the walls. One building was found where bolts had been set for anchorage of the roof, but neither nuts nor washers had ever been placed on them.

It is unfortunate for the building industry in general and for manufacturers and users of concrete masonry in particular that the speculative builder seized on concrete block as the most convenient material available. As the building inspector of Orlando so well stated, unscrupulous block makers set up their establishments outside of city limits, used fine beach sand or any other material they could get, added just enough cement to hold the units together, knowing well that they would find a ready market with the speculative builder. He was interested only in having his building stand up until it was sold. The result was that during the building boom of the last few years concrete block was used by the speculative builder to a far greater extent than all other materials combined. Consequently, while many jerry-built structures of other types of construction were destroyed, the preponderant use of concrete masonry in the speculative field resulted in a total number of concrete block failures that will reach unpleasant figures.

Manufacturers and users of concrete masonry have every reason to be satisfied with its performance wherever it was built under a building code and under the supervision of a city building department. The story of the excellent showing of concrete masonry in Coral Gables is quite enough to establish this material as safe construction in parts of the country subjected to hurricane devastation.



Miami Electrotube Building, Coral Gables, looking N. E. An unusually long wall of 8-inch block, without pilasters or other support. Four-foot parapet wall blew over, allowing wind to enter upper story and cause failure. The building code was violated in this structure, one of few damaged there.



The Apartment Garage, on the beach to the south of the Hollywood Beach Hotel, was completely wrecked. Part of the damage was caused by the impact of sidewalk slabs blown up from the beach against the structure as shown.

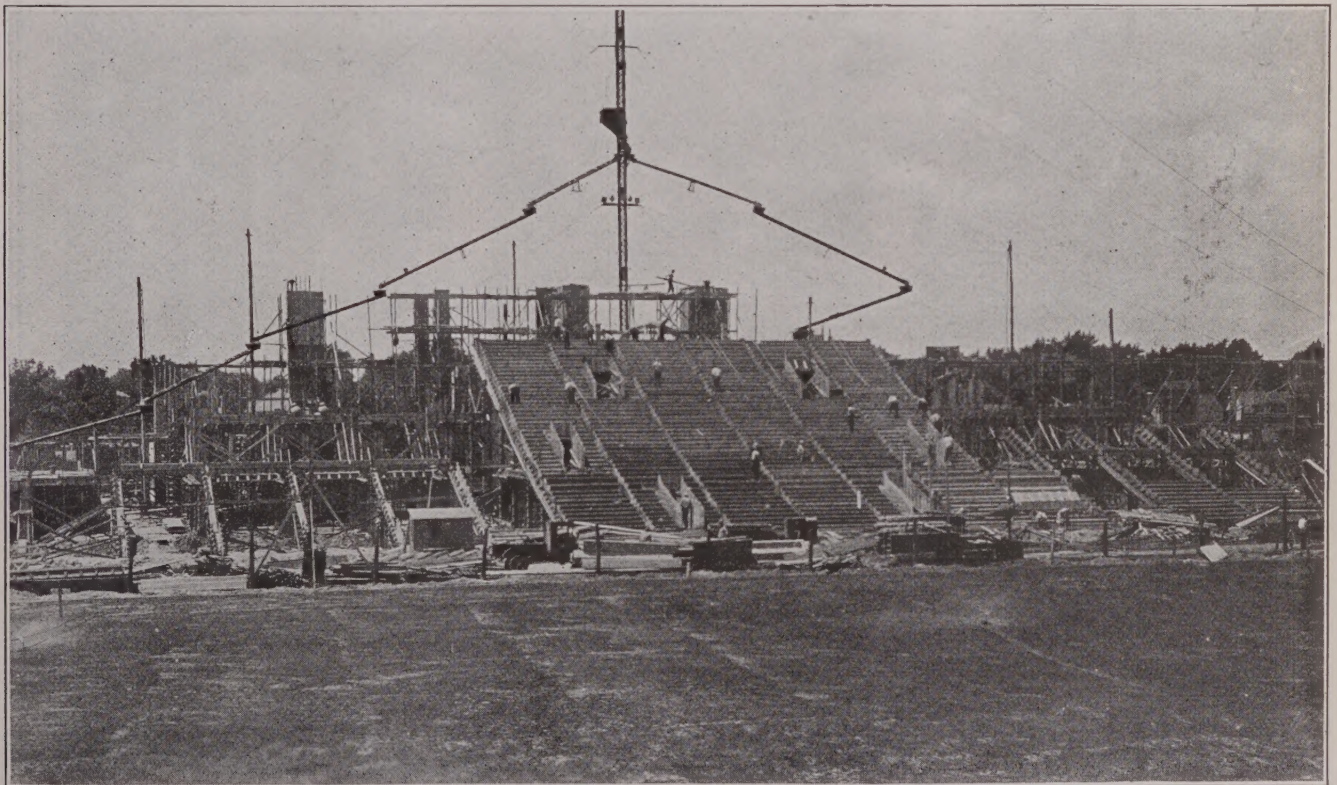
Good Concrete on a Rush Job

High Strengths Secured as Stadium Is Rushed for Opening of the Football Season—Latest Type of Mixing Plant and Laboratory Control Assures Quality with Economy—Form Kinks and Other Methods Prove Interesting—An Interesting Design That Will Please Spectators

NORTHWESTERN University, a member of the "Big Ten," opens the football season this year with a brand new but uncompleted stadium of the very latest type. An ambitious project as it stands, this great reinforced concrete and steel structure is planned for even greater future expansion. This year it will have two sides, each of two decks. Eventually it will be expanded, if the zoning ordinances can be made to permit the work, to have three decks. Some day one end will be enclosed to give the structure the desirable and imposing horseshoe shape. When all this work is done, and it will be completed as soon as the growth of the school makes it advisable, every seat will afford a good view of center field, for each deck is designed according to the scientific principles that afford the best lines of sight.

The manner by which scientific principles were applied to control the strength of the concrete on this important work, the design and placement of the concreting equipment, and form ideas utilized by the contractor are of especial interest. The control system centers about a practical application of the Abrams Theory. The concreting plants, for there were two of them, were what might well be called the "Chicago Type." The various unusual "kinks" observed on the job were some of them originated by the

Designed by a foremost authority on modern stadiums, and built by a good contractor under the supervision of the designers, the new stadium just built for Northwestern University, in Evanston, Ill., contains a number of interesting features. The strength of the concrete was controlled by means of the application of a strength specification. The fact that strengths actually secured have been uniformly well above those designed for, together with the fact that the cost of the concrete in place has been well below that of the usual mix, have spoken well for the work done by the engineers. Then, too, a great many interesting form details, worth application on other work, have been observed and are presented here in pictorial form. This story of the work will prove well worth reading.—The Editors.

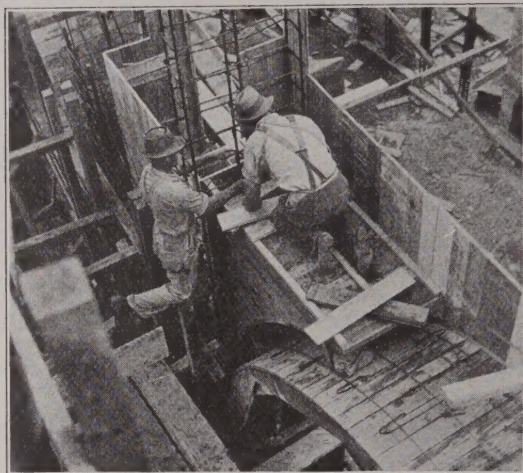


One side of the work at an early stage, showing the location of the mixing and chuting plant, and successive stages of the operations

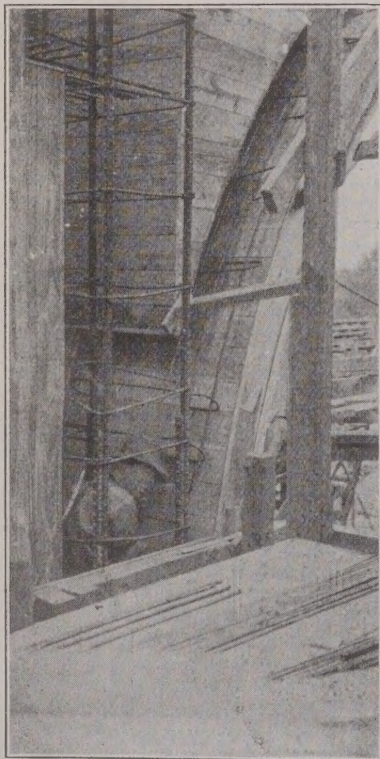


The centering for two great arches may be seen here. This system is simple and economical, since erection and stripping are easy and the parts may be used over again.

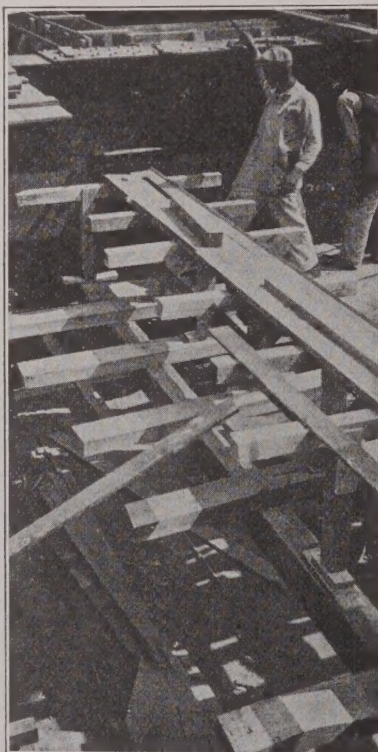
Form Details That Worked



Here is the next step in forming the arches. The reinforcing is being set.



Another view of the arch forms, with core form and column reinforcing in place, taken at the spring line of the arch.



Here the carpenters are forming the juncture between a reinforced concrete girder and a structural steel girder.

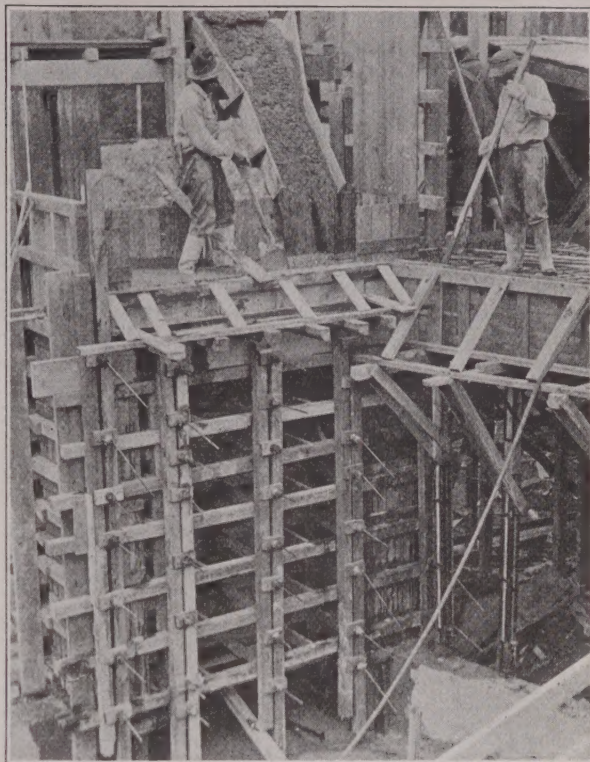


This is how the contractor used column clamps and patent shores in forming a column and beam assembly.

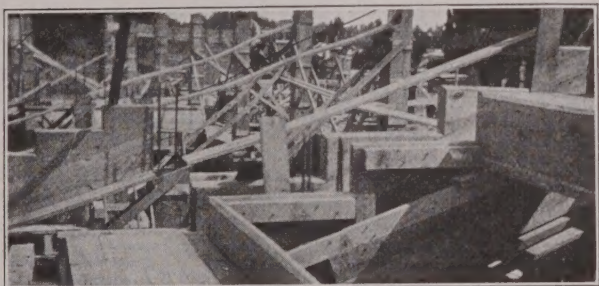
Form Kinks from the Wildcat Stadium



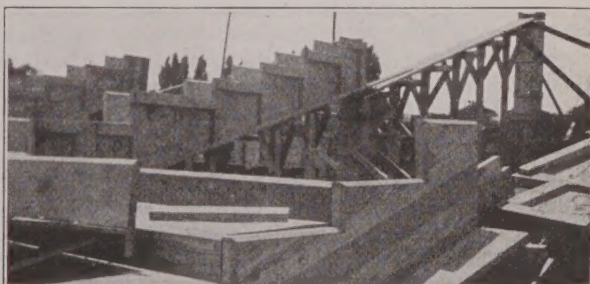
Setting the forms for a beam and slab floor—a simple system.



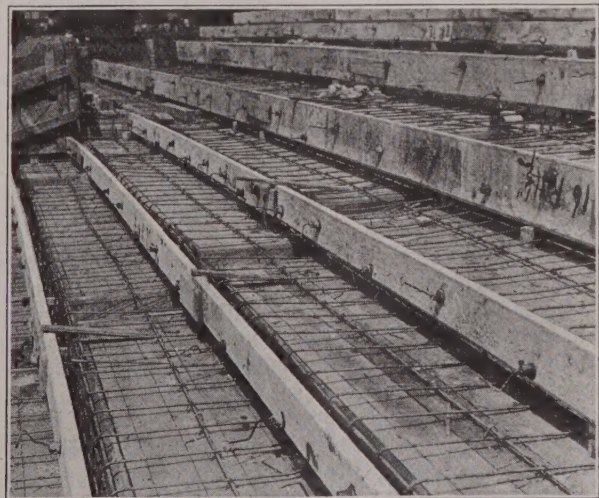
Here is another interesting form detail, with the concrete being placed in beam, column and wall



Here are the tread and riser forms being set for the seat deck.



Another view showing the tread and riser forms for the seat deck.



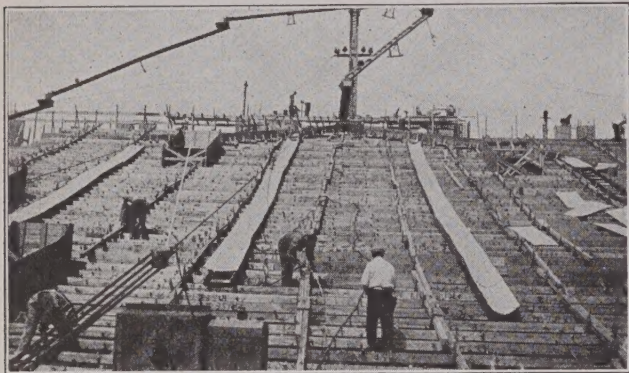
Here is a seat deck section with reinforcing in place, ready for the concrete.



Placing the concrete for the bottom ramp by means of buggies. Note the forms.

engineers and some by the contractor. A better understanding of the methods used will be gained when the general situation is examined.

The contract just being completed called for the construction of two sides of the stadium, seating 40,000 people, together with the construction of a new playing field of the latest type. The engineers estimated that, in all, 15,000 cubic yards of reinforced concrete would have to be prepared and placed. The first deck of each structure, together with its supports, as well as the ramp towers, were to be of reinforced concrete on mat footings. The second or upper deck was to be of reinforced concrete on structural steel supports carried on the reinforced concrete of the lower level. The site was found to be well away from the railroad, but located on one side of the main streets leading out of Evanston, with an alley on



Some parts of the deck were concreted with the aid of sheet metal troughs that carried the concrete from the chutes to the forms. The forms were first thoroughly cleaned with the aid of the hose.

either side of the project. Thus the work had to be laid out for the handling of an enormous quantity of materials, all of which had to be delivered by motor truck.

Two Mixing Plants

Since the two halves of the structure were too far apart to handle from one central mixing plant, and since the concrete had to be lifted well above grade, the contractors decided to install a separate mixing plant for each half of the work. These units were built with Blaw-Knox batcher-plants, equipped with inundator and volumetric batchers. No surplus material was to be stored on the job, so truck deliveries to these batcher-plants had to be frequent enough to keep things running.

The plants were located alongside the rear center of each structure. The trucks delivered aggregates and cement through the alley, dumping the aggregates into a hopper so built that the trucks had to back up a short ramp to deliver their load. The cement was stored in a cement shed which was part of the plant structure. The aggregates were elevated from the hopper to the bin by means of an electrically operated bucket conveyor, which discharged the materials into the elevated bin through a two-way spout. Gravity then carried the gravel through the batcher and the sand through the inundator and to the $\frac{3}{4}$ -yard Marsh-Capron mixer, which was also electrically operated. The mixer discharged into the bucket of an Archer distributing tower. This steel tower was of the type ordinarily known as the highline system, being made up of a combination of guy line and gin pole units. From the top of this 200-ft. tower the concrete was spouted to a field hopper, and was there, discharged into buggies for delivery to the forms. During part of the work, utilization was made of a series of sheet metal troughs laid on the forms, which chuted the concrete into the forms without further handling.

Each of these mixing plants was handled by a crew of six men. One man handled the levers controlling the inundator, the batcher, and the mixer, two men kept the cement sacks moving, one man kept the bucket elevator feeding material to the bin, another man took care of the mixer discharge, and one man on the tower controlled the hoist. An inspector, working under the resident engineer, completed each of these two crews. It was his particular job to check up on the proportioning of each batch, its water content, and the resulting consistency. The tower man, too, performed somewhat the functions of an inspector, since he observed closely the action of the material in the chutes, and directed any needed change in the water content to afford drier or wetter mix as his judgment might dictate, in order to obtain a mix that would chute as well as desired. This change in consistency was made without altering the water-cement ratio, since that function was fixed by the resident engineer.

Specifications Posted

Now here is an interesting feature that was to be observed at each of those mixing plants. The engineers in charge of the work are great believers in letting the men know what is being striven for. They are confident that the average American workman wants to be able to point to his work with pride, and to be able to say, no matter how small his share in the work might have been, that the job is a good sample of what he can do. The foremen, especially, take that sort of an interest in their work. It is then logical, they believe, to take the foremen, and even the men under the foremen, into their confidence and impress upon these men the way in which things must be done on the job. Thus, with a project where a new order of things was being instituted at the mixing plant, it occurred to the engineers that a better concrete would result with the co-operation of the men on the work. To enlighten the men, copies were made of the specification clauses on proportioning by the Abrams Theory, and these copies were posted on the batcher-plant in front of the man who handled the proportioning and water tank levers. These paragraphs set the men to talking and to asking questions, so it was not long before every man at the plant had been given a first rate opportunity to find out what it was all about. There is nothing like it, say the engineers, to impress upon the men the necessity for close adherence to the specification provisions that rule the concrete plant.

Care of the equipment was an important item with the plant crews. It was a practice at each plant to clean all equipment thoroughly with a stream of water from a fire hose at the beginning and end of each day's work. The mixer, the proportioning devices, the hoisting bucket—all had adhering material carefully removed by this means twice each day. Such treatment added, naturally, to the life of all equipment. The forms, too, were always carefully flushed clean with the hose before concrete was placed in them.

A Cheaper Concrete

Before taking this job, the contractor had been used to using an ordinary 1:2:4 concrete, and giving it plenty of water in order to obtain workability. The engineers on the stadium, however, had been studying the methods proposed by Dr. Abrams and other investigators, and now used by many concretors, so they decided to adopt two classes of concrete for the work, using a strength specification, and then design a mix in the field that would deliver the desired strengths with the maximum of economy. After demonstrating to the contractor at the beginning of the work that the desired strengths could be exceeded with a lower cement factor and a better workability, the engineers received his fullest co-operation.

The engineers' office shack on the job contained a small laboratory equipped for making screen analyses, moisture, and absorption determinations, and had facilities for making slump tests and the casting of test cylinders. The engineer established the fineness modulus of the aggregates, moisture determinations, and found the absorption, and upon this basis designed a mix that would give the required results. The proportioning equipment at each plant could then be set for the needed proportion, and corrected when check determinations made it necessary. The aggregates used were Nos. 6, 8, and 9 washed Beloit gravel, and Beloit torpedo sand.

The basic mix was nominally 1:2.76:3.40, and with the required water content the mix was supposed to deliver 2,000 pounds at 28 days. The 3,000 pound concrete was secured simply by the addition of one sack of cement to the batch beyond the requirements of the base mix. Records showed that the base mix frequently gave as high as 1900 pounds at 7 days, while the 3,000-pound concrete was actually breaking as high as 4200 pounds. The average batch exceeded the required strengths by 1200 to 1600 pounds. The concrete usually was found to have a slump of $6\frac{1}{2}$ to 7 inches. The actual testing of the cylinders, together with the testing of the cement, was taken care of by another organization, the Robert W. Hunt Company, and it was their tests that kept the engineers fully informed as to the status of the concrete. The computations for the design of the mix according to the fineness modulus and the ratio of cement to water were accomplished according to the recommended practice.

Worthwhile Forms

Without an efficient form arrangement it would be difficult to erect a great reinforced concrete structure at a normal cost. The form system on the stadium proved quite worthwhile. The columns and girders were formed in a quite usual manner except that use was made of patent form clamps, shores, and tee-heads wherever possible. The seat deck was cast in the form of treads and risers, somewhat as stairways are formed. The pictures reproduced here will show just how it was done. Steel seat brackets had to be anchored to the risers, so a special anchor device had to be attached to the riser form. Since the anchor device was in the form of a spiral coil of heavy wire, so wound as to take the threads of an anchor bolt, the anchor was attached to the inner face of the riser form by means of a temporary bolt passing through a hole drilled in the form. This system was found to be quite practical, and in but a few cases did drilling and the use of an expansion bolt have to be resorted to after the forms were stripped. The seat brackets were fastened to the risers, after the concrete had hardened, by means of bolts gripped by the spiral seat cast into the concrete. These bolts were driven by a portable electric device that was also used as a drill and as a screwdriver. Before driving, these bolts were dipped in red lead to eliminate rusting. Redwood planks were screwed onto these brackets to afford seats. The holes for these screws were drilled by means of the portable electric drill, and the screws were driven by a portable electric screwdriver. These devices speeded up production at a great rate, and kept the men on the job. They easily paid their own way, since a great many operations had to be accomplished in a short time.

Arch Forms

Each side of the stadium, as seen from the rear, consists of a curved wall of arches, starting low at each end and increasing in height to the center, inside of which is a second and similar wall of arches. Connecting the two walls is an arched ceiling. This inner wall carries the rear

of the seat deck. The problem of forming these reinforced concrete arch walls was solved in a very interesting manner. The arches were formed by two or three standardized types of centering, as shown in the photographs. The arched roof connecting the two walls was made by means of a metal lath bottom form, shaped to the right contour, on which was placed the reinforced concrete and stucco. The metal lath was carried on wood centering. The arch centering was easily assembled, and just as easily stripped,



The massive structures are carried on great spread footings. These were heavily reinforced, as may be seen here.

and costs were therefore as low as could be desired. These arches have spans ranging from 20 to 23 ft.

An interesting finishing method was utilized after the forms were stripped. All exposed work was first patched, and then ground down with a portable electric finishing machine to remove fins, and so on. The surface was then washed with a grout, and this in turn ground into the surface with the carborundum finishing machine. The result was a smooth surface of even color and texture that looked quite like limestone. It proved very pleasing, and cost but little to secure.

Curing the Work

All slabs were cured by covering with wet sawdust and sprinkling for ten days in order that full strengths would be developed. The seat decks were reinforced with $\frac{3}{8}$ -inch bars, since the $\frac{1}{4}$ -inch bars often used in a slab of this sort are very hard to keep in place during the placing of the concrete. The slabs are three inches thick, supported by four-inch riser beams framed into reinforced concrete girders. These slabs were divided into sections to take care of expansion. The joints were filled with expansion joint material, and sliding was provided for by means of overlapping sheets of tar paper one end of each flashed into the concrete.

The stadium was designed by James Gamble Rogers, architect, and Gavin Hadden, engineer, associates, of New York City, and the inspection on the job was afforded from their office. The general contract was executed by J. B. French & Co., of Chicago. The designers were represented on the job by G. F. Baker, resident engineer, F. W. Wrede, assistant engineer, and a corps of inspectors. According to Mr. Baker, the structure was designed in accordance with the most modern knowledge of optical principles, both to afford the best possible view for every spectator, and to give an imposing exterior that would have pleasing lines and be a natural expression of the material and the purpose of the structure. It may therefore be considered a good example of modern stadium design and construction.

The Development of Concrete Reinforcement*

Spirals—Deformed Bars—Early Types of Deformed Bars
—Warehouse Distribution of Reinforcing Steel—
Standardization—Growing Tendencies Toward Shop
Fabrication.

By A. E. LINDAU

PART I of this article, published in the October issue, covered the development of concrete reinforcement from its earliest known uses through the quarter century preceding 1900 during which many systems of reinforcing were developed, up to the beginning of the twentieth century.

PART II carries the story forward from 1900 to the present time and discusses present and probable future tendencies in the development of concrete reinforcement.

Part II

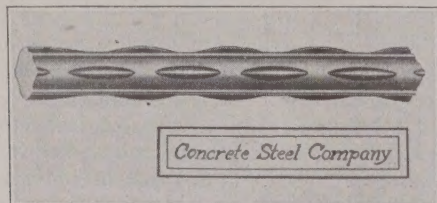
1900—to Date

THE *System* period was a time when the specialist groped in the dark after the answer to the problem of efficiency in reinforcement. Little real information was available regarding the important functions of reinforcing.

One designer conceived the idea that it was important to place the steel in a certain manner and others held different opinions, all of them relying on their more or less slight knowledge of mechanics and principally on their own experience.

We have seen how the idea of reinforcement grew from the simple but effective rod or mesh system of Monier, through the complicated special systems of Cattancin, Coignet, Chaudy, etc., to the simple and, from our point of view more orderly system of Hennebique. We have seen the idea of the deformed bar given some attention, although it was common doctrine that a plain bar imbedded 40 diameters in the concrete would break before it could be pulled out.

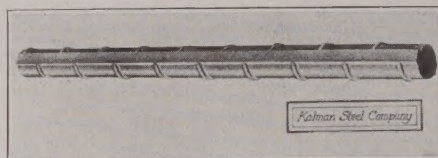
We have seen the idea of fabricating the reinforcement into units, especially for beams and columns, grow to a



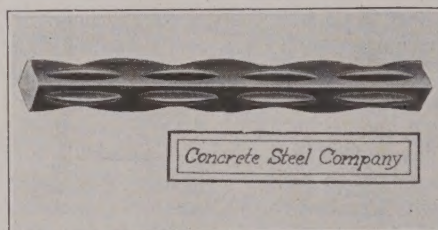
point that is only being approached at the present time. Stirrups and continuous web reinforcement of various

kinds were made the special features of some of the systems, but the whole was clouded in a mass of detail, and without experimental data and engineering authority remained a subject of controversy and mystery until cleared up by scientific research that began about the first of the century in this country.

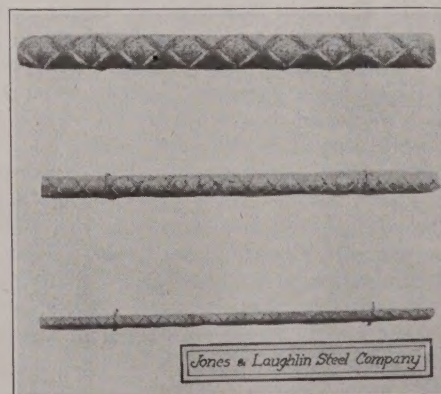
Twenty-five years ago the dominating figure in the industry was Hennebique. He simplified and organized the methods of using reinforcement to a remarkable extent.



In fact we are today using substantially his forms and details. Prior to 1900 he had built thousands of structures and established agents in many countries outside of France. He used plain bars hooked or split at the ends to



anchor them even though it was insisted that the bond between the concrete and the steel was absolutely secure.



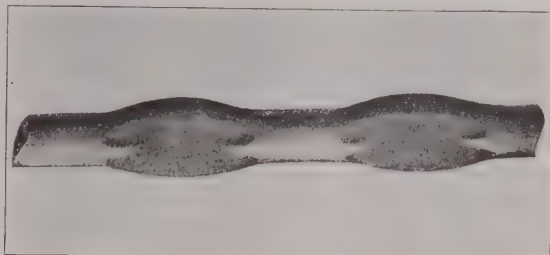
Reinforcement

Spirals: One of the most original and valuable contributions to the art of reinforcement was made by Considere

*Paper delivered at the meeting of the Concrete Reinforcing Steel Institute, September 14.

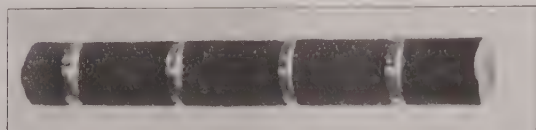
in 1902 when he described his method of reinforcing columns by imbedding a helical spiral near the outer surface of round columns. By this device he found that concrete could be greatly strengthened in compression. This suggestion seemed at first a slur on the fair name of concrete. All users of reinforced concrete could understand the need for improving its tensile strength but looked askance at the idea of adding to its strong qualities, i. e., compression. Time and painstaking research have fully justified Considere's claims. The use of spiral reinforcement is now universal and has done more to make our 18 and 20 story buildings of reinforced concrete possible than any other single factor.

Deformed Bars: One of the most surprising and interesting features in connection with reinforcement is the

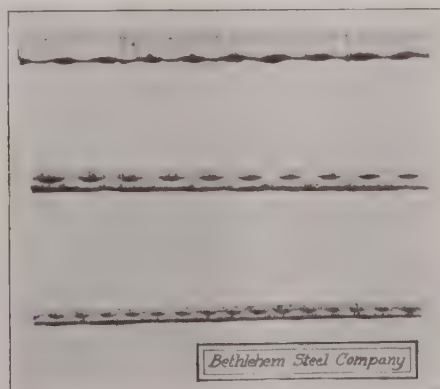


An early type of deformed bar

marked difference in practice in this country and the rest of the world. In Europe, where reinforcement was first used and where nearly every form was tried, the practice today remains as it began 70 years ago—largely plain round bars hooked at the end for anchorage but not otherwise specially prepared. In this country, on the other hand, 80 to 90 per cent of the bar reinforcement is some type of special section classified as deformed bars. The deformed bars in this country played a role similar to that of the *Systems* in Europe. The whole idea of deformed bars revolves around the theme that if we are to realize the fundamental assumption in reinforced concrete con-

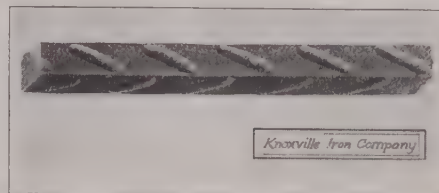


struction the two materials must work together, that is, be intimately connected at all points at the surface of the reinforcement. When this connection is broken we no longer have the kind of structure that our assumptions would predict.



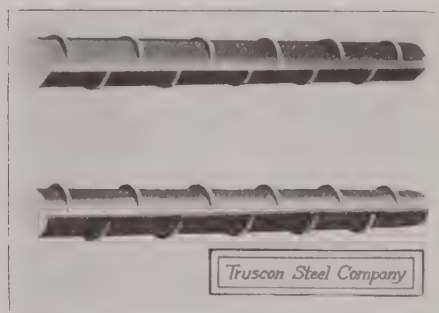
The fundamental importance of safeguarding the bond between the materials justifies the great efforts that have been made to reach the best answer to this question. Again much of the pioneer work into this feature was done before

experiment could throw any light on the question. E. L. Ransome is easily the pioneer in this country. By twisting a square bar he hoped to secure a section that would resist or retard the breaking of the bond. It was also expected that the twisted bar would have an increased yield point and in respect be superior to the usual grades of bar steel. For many years twisted bars were considered highly efficient deformed bars. Careful laboratory tests have shown



the twisted bar to have the same characteristics as plain bars.

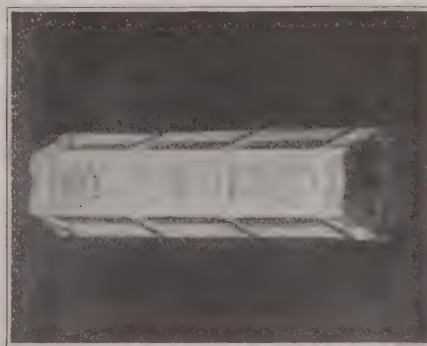
The problem of the deformed bar is to find a pattern of projections or depressions on the surface of the bar that will produce resistance to sliding, be practicable from a



rolling mill standpoint and yet not add materially to the weight of the bar.

Properties of Deformed Bars

Many types or patterns of bars have been produced, most of which are still on the market. To begin with deformed bars were received with misgivings and doubts, but here again research came to the rescue. Test data has shown beyond question that deformed bars as a class are superior to plain bars. The smoother the bar, the lower its bond value. The plain bar advocate contends that the bond of the plain bar is sufficient and that the ordinary commercial plain bar is rough enough to yield the required bond value. The deformed bar advocate on the other hand contends that it is not good engineering and far from scientific to leave this important property of reinforcement to the accidental condition of the finishing rolls of the steel producer.

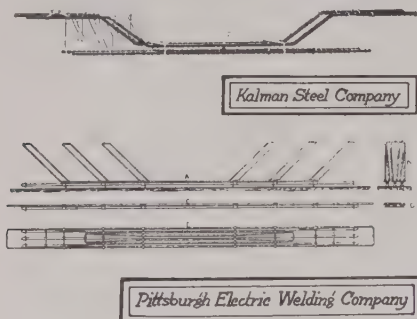


Further research is desirable to determine the most efficient type of deformation or surface patterns and some degree of standardization along this line would without question be of value to the industry. The tendency in

structural engineering is to increase the working stresses in the materials. Increase in the bond stress can only be justified by increased bond resistance of the reinforcement.

A further difference in the practice in this country and Europe is the use here of higher yield point steel. A high yield point warrants a higher working stress and consequently a saving in material. The only limitation to a high elastic limit steel is ductility. Fabrication demands a steel that will stand cold bending without injury for all the various forms of shaping required.

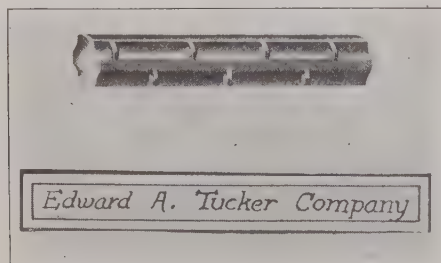
These two limitations are the only important elements determining a satisfactory grade of steel. It would seem that these could be met by single standard specifications,



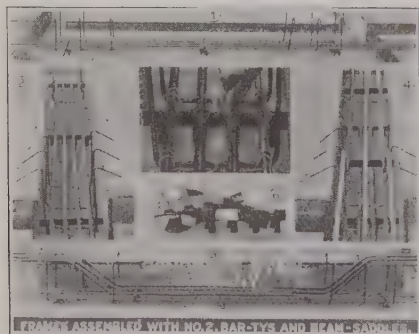
but the problems of the producer and variation in the demand of the user are still burdening the industry with several specifications. A movement to eliminate the waste incident to this situation particularly as regards new-billet steel has been inaugurated by the division of simplified practice of the Department of Commerce. If the various elements can be harmonized and a single specification be adopted great economies will result and untold minor delays and irritations in the distribution of reinforcement will be eliminated.

Warehouse Distribution

Another important development in the last quarter century in this country is the growth of the warehouse system



of distribution by firms specializing in the sale of reinforcement. In this respect also the practice in this country is widely different from European practice.



It is customary now to begin work before the detail plans are completed. Added to this situation is the lack of storage facilities, especially in the large congested cen-

ters where the bulk of construction is carried on. The material must be delivered in small quantities in the order in which the work progresses. To meet this condition deliveries are made from local warehouses scattered throughout the country so organized as to furnish the reinforcement from day to day fabricated and ready to place in the forms. To what extent this practice speeds up the work and eliminates costly delays is difficult to estimate, but it is one of the important factors in developing the reinforced concrete industry today.

Standardization

As the level of wages rises cost of production must rise unless it is restrained by labor saving machinery and effi-



ciency in organization. The development of the fabricating warehouse has taken the fabrication of reinforcement away from the job and placed it in the shop. Power bending and shaping of bars and rods has replaced the old hand operations. Trained shop crews and production methods have replaced the temporarily organized and frequently unskilled crews at the job.

To obtain the full benefits of shop methods requires standardization. We have seen how every conceivable form and size of bars and rods have been used from time to time. The full value of production methods and economy are impossible under such conditions. A great step in this direction has been taken by the universal adoption of eleven standard sizes of reinforcing bars and the standardization of spiral rods. On the score of economy alone the tendency is for more and more shop fabrication. In view of the fact that merely placing the bars in the forms is at present costing \$15 to \$20 per ton while the fabrication at the shop costs about one-half that, it is clear that field fabrication is a thing of the past.

The demand for accuracy in position of the reinforcement has brought out a host of fastening and spacing devices. Compared with the old haphazard method of resting the bars on the forms and pulling them in place as the connecting progressed—the designer has now more assurance that the reinforcement will occupy the positions intended by the plans.

The tendency is towards more and more shop fabrication to greater standardization in details. We seem to be moving in the direction of the complete fabrication and assembling of all the reinforcement for each structural member. We may look forward to the time when the reinforcement is so designed and fabricated that the entire reinforcing skeleton is fastened together and erected in such a manner that it can carry the formwork.

American Society of Mechanical Engineers to Meet

A parallel meeting with the Fifth National Exposition of Power and Mechanical Engineering will be held by the American Society of Mechanical Engineers in the Engineering Societies Building, 29 West 39th Street, New York City, from December 6th to 9th, inclusive. This will also be the annual meeting of the society.

The Exposition will be held from Monday, December 6th, through Saturday, December 11th, at the Grand Central Palace, from 12 M. to 10:30 P. M. daily.

EDITORIALS

Opportunity for Concretors

AN indication of the tremendous possibilities ahead of the concretor is found in an examination of construction statistics and tendencies. They are the guide boards that show the trends and indicate possible future developments.

While there are those who say that the peak of development for reinforced concrete construction has been reached, still new uses are constantly being found and old uses are being more intensively developed. Not long ago the boom in highway development provided an entirely new outlet for millions of cubic yards of concrete. There are indications now that the railway field may provide a market of equal magnitude in the future. And other possibilities as yet unsuspected may be just around the corner.

The rate of increase in the use of cement may be considered as parallel to the rate of increase in the use of concrete. Cement consumption grows at the rate of about 5 per cent per year, while population increase is only at the rate of $1\frac{1}{2}$ per cent each year—an indication of the continued development of new markets over and above simply normal growth. It is reasonable to expect that with the complete development of all new markets, the rate of increase in the use of cement will diminish until it becomes more nearly parallel to the rate of population increase.

Steel production statistics provide an interesting example of the manner in which the use of reinforced concrete is developing. The consumption of reinforcing bars is increasing at the rate of about 5 per cent of the present tonnage. In contrast to this growth, the consumption of fabrication steel for the 10-year period from 1911 to 1920 has not gained in equal proportions. The tendencies in steel sales reflect the present reaction of concrete on the steel industry.

Yet, with all these seemingly optimistic indications, the fact remains that the use of reinforced concrete is not growing as rapidly as the total volume of construction. This may be explained, in a measure at least, by the fact that in recent years there has been an abnormal increase in residential building in which little reinforced concrete is used, though it provides the principal market for precast concrete units.

There are big opportunities for concretors everywhere, but the increase in concrete construction will depend to a large extent on the activities of those who know the advantages of concrete as a building material. The industry can grow but slowly if the growth represents only the normal increase in the total volume of construction. The future of the concrete industry and of those engaged in it lies in the degree in which concrete will be used for structures that are now being built of other materials.

Building Codes Justified

THE Florida hurricane has revealed some important lessons with startling clearness. Foremost among these is the very real value of comprehensive building codes and the necessity of their rigid, impartial enforcement.

Already officials of some of the devastated cities are planning definitely to write some neglected provisions into their building codes and are taking steps to revise other provisions in the light of their recent experiences. A statement by the chief building inspector of Miami is significant: "No particular type of construction resisted the hurricane better than other types, and there is nothing to show that some types are so weak as to be out of place in districts subject to hurricanes. From a broad study of the effects of the September 18 hurricane it must be concluded that every type of construction, when intelligently designed and properly built, proved itself capable of resisting."

The Florida hurricane will give rise to much comment upon the performance of this or that type of building material. But such claims miss the main point—that ALL types when properly built and carefully designed gave a good account of themselves.

The outstanding fact is that in no case were residences or small buildings that were built under the provisions of some adequate code, destroyed. An example is found in Coral Gables, where concrete masonry buildings, erected under the provisions of the Hoover Building Code, suffered exceptionally slight damage. Less than 3 per cent of the buildings were seriously damaged and the total loss, including trees and landscaping, was less than $1\frac{1}{2}$ per cent of the original investment.

Inside the corporate limits of cities having and enforcing the building codes the damage in general was comparatively light. The havoc was wrought outside the influence of a building code where the jerry builder held sway. Here walls of concrete units and other types were laid up with inferior mortar. They were not stiffened with reinforced concrete pilasters as is required in good codes. Floors and roofs were not tied to the walls and other provisions covered in building codes were disregarded. The results were inevitable.

Now, while the sad effect of the hurricane is still vividly in mind, the lessons that it taught will be needed. But it is unfortunate that hurricanes and earthquakes are necessary to focus attention on the ever-present need of fair building codes and effective building code enforcement.

Here and There

Some Random Notes on Visits with Concretors in the Field

SCIENCE is invading the job office on concrete construction jobs.

Nowadays when you ask a concrete contractor what mix he is using he is liable to quote you a mix that runs into a lot of small fractions. It suits him fine, too, because nine cases out of ten the contractor gains by this scientific proportioning stunt and he finds that it isn't nearly as bad as it sounds before he tries it.

* * *

IT isn't so hard to get the mixer men interested in this matter of quality concrete. Most of them are fellows who are anxious to learn and to make a record on their jobs. One contractor conceived the idea of posting the specifications on the wall near the mixer and took time to explain to any of his men that were interested what this matter of quality control really was. As a result, his foremen and mixer men were working with him 100 per cent. The men were getting a lot out of it, too, because they were training themselves for bigger jobs.

* * *

HAVE you ever thought of the important part that cement plays in this business of quality control of concrete? Without a standard quality of cement that can absolutely be depended upon, it would be impossible to predict the strength of concrete no matter how carefully and accurately the aggregates are proportioned nor how painstakingly the water-cement ratio is controlled.

In every cement mill there are earnest young men who watch the proportions of the raw materials that make cement like hawks and they would rather shut down the entire mill than allow a bag of cement to go out that did not meet the specifications upon which you base your quality control of concrete.

* * *

WE pulled the old bus up in the shadow of one construction office and pretty near stepped on an experiment in scientific proportioning. The contractor and the engineer were there "quartering" a sample of aggregate for a fineness modulus determination. There was a batch of aggregate on the floor and the engineer was taking away portions of it and then bunching the rest up and taking away some more. Wanted to get a true sample, he said.

Then the office had a lot of sieves and scales and slump cones and such things. This looked like the real thing in quality control, so we asked the contractor how he liked the system.

"It's just a matter of getting used to it," he said. "Once we get the hang of it, we like it. And you should see the tests we are getting." And the contractor got all enthused over the fine concrete that he was making with this quality control.

"When we get further along with this job we will tell you all about our troubles and our successes so that you can pass them on to your readers," he promised.

WE ran onto a queer thing on one big job that made us think that the tables are reversed now on this matter of inspection. Seemed as if the contractor would need an inspector on the job to see that the engineer wasn't skinning him!

Here is how it was. They wanted 3,000-pound concrete and the engineer let the contractor choose his own mix as long as he stuck to the specified water content per bag of cement. Well, the contractor knew he had to make a darn good concrete so he chose a 1:2:3 mix. That was OK with the engineer and the job went ahead with everybody happy.

Then one day the contractor asks the engineer how the concrete measured up. "Oh, fine," says the engineer, and then quits talking. As a matter of fact, that concrete ran away above the specified strength of 3,000 pounds, but the engineer let the contractor go on without telling him that he could have cut down on the cement content and still get concrete that would meet the requirements with the aggregates he was using. That contractor needed an inspector to see that the engineer wasn't slipping something over on him.

* * *

IN one of our large cities some contractors were putting in the foundations for a large building. They had a building code in that city that said that concrete must be of a 1:2:4 mix.

But this contractor was proportioning his concrete scientifically and was taking advantage of the savings that made possible. Along comes the city building inspector and says, "What mix are you using?"

The contractor tells him, with some fear of the result. "Nix on that," says the inspector.

"Well," comes back the contractor, "why do you specify a 1:2:4 mix? To get good concrete, not so? Sure! Well, I'm giving you good concrete." And they tested his concrete in the laboratory and found that it was a lot better than most of the concrete that was going in at the 1:2:4 mix, so they let him go ahead, and didn't give a darn what the mix is so long as the concrete is of the required quality.

* * *

JUST what is a quality control job? That was the poser asked recently by one fellow that knew concrete work from A to Z. We wondered then, too. If a "quality control" job is only one on which every known principle of controlling the quality of concrete is applied, there are mighty few of such jobs under way. But if it means that every job on which some attention is paid to proper aggregate combinations and in which the water content is closely watched, then there are many jobs in every section of the country on which the quality of the concrete is controlled. And on some of them accurate, scientific means are employed to eliminate as far as possible those elements that are detrimental to concrete at its best.

Contractors everywhere are working on this problem of getting the best concrete by the most practical methods. Some of them have developed interesting methods that have proved entirely practical. These will be described from time to time in the pages of this journal so that other concretors can benefit by them.

An Athletic Stadium on a Paying Basis

Successive Steps in Financing, Construction and Operating Methods Are Explained in Order That the Concretor Will Be Better Able to Aid in the Promotion of Such a Structure for His Own Community

The first part of this story, appearing in the October issue, gave details about the promotion, financing and organization required for a new stadium project in the average community. The second installment, in this issue, deals with the structure itself, operating arrangements, division of receipts, scheduling the games, charges for admission, numbering of seats, the use of special attractions to obtain extra revenue, the utilization of the space under the seat deck, and a set of plans for the typical stadium for a high school or small college in a medium sized community. These two articles form a reliable guide for those interested in the promotion of such a project.—The Editors.

(Concluded from the October issue)

Plans and Construction

IN the selection of the designer and the builder of a small stadium local pride should be set aside unless really competent and experienced local talent is available. In several instances misguided local pride led to the employment of inexperienced designers and contractors, the final product proving, as might be expected, to be an unsatisfactory and expensive structure. The stadium association should engage a structural engineering designer experienced in such work, and bids should be invited from contractors who have a record of the successful completion of similar structures, whether they are local or outside firms.

Type of Structure

Ordinary common sense would dictate the selection of a type of construction that is permanent and will not require heavy maintenance costs. Nevertheless, in a few instances penny-wise-and-pound-foolish policies have resulted in structures which can easily be destroyed by fire, or which will require heavy maintenance charges for painting and repairs, or both.

If a community is fortunate enough to have a natural site in a ravine or other natural depression, a permanent and absolutely safe and maintenance-free structure may result by laying a concrete slab directly on the graded slope. A number of structures have been built in such locations, and in one instance on the Pacific Coast a large stadium was built in that manner on an artificial fill placed by the hydraulic process. Where a natural depression is not

available, the seat deck may be carried on a reinforced concrete structural frame. The resulting structure will be absolutely fireproof, it will not deteriorate, and it will require but little attention from the standpoint of maintenance.

Operating Arrangement

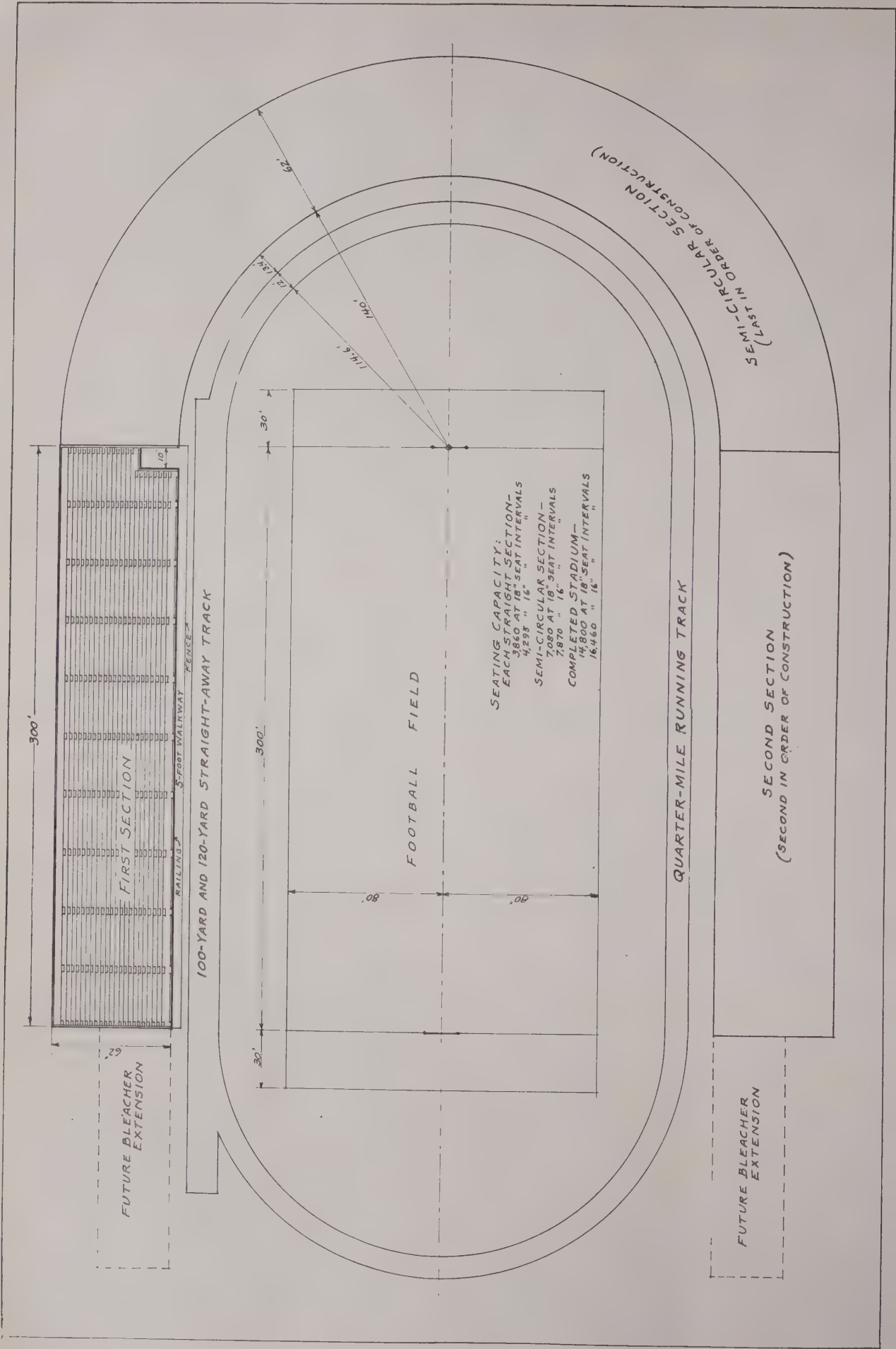
There must of course be some form of operating agreement between the school board, the stadium association and the athletic association. In most instances the school board, as such, has taken little part beyond granting a lease to the stadium association covering the school property to be occupied. When all the bonds are retired and other obligations taken care of, the lease will be surrendered to the school board and the stadium automatically becomes the property of the city. In the meantime, of course, it is considered to be the property of the non-profit corporation which we have called the stadium association.

Division of Receipts

A typical and successful operating arrangement is the one in a city of about 60,000 people. The stadium association pays the school board a nominal rental of \$1 per year for the ground lease. Gate receipts obtained are divided, one-third going to the stadium association and two-thirds to the athletic association. At the end of each playing season the athletic association turns over to the stadium association any surplus that may remain after its own expenses for coaches, doctors, traveling expenses and guarantees are paid. This surplus is, of course, applied to the payment of interest and retirement of bonds. The stadium association operates with a low overhead expense, inasmuch as all the officers donate their services, while the clerical work is handled by the office force of the secretary of the school board. The stadium association's only expense consists in the maintenance of the athletic field, furnishing the staff for selling tickets and handling crowds at games, paying for printing and advertising of games, and arranging for the publication of news stories. These expenses, exclusive of ground maintenance, are said to amount to about \$100 per game. The stadium association is paying off its obligations rapidly and expects to retire the last of the bonds within ten years following the completion of the structure.

Scheduling Games

Every high school and college has a well-advertised rival school whose football team invariably draws the crowd. That team should be scheduled for Thanksgiving Day. The next best drawing card should be scheduled for Armistice Day. This policy has been followed consistently for four or five seasons at a high school stadium that has been a financial success. It is said that, figuratively speaking, the entire town turns out to the athletic stadium to see the game with the hated but respected rival. In another city, somewhat smaller, where the stadium has been operating for three seasons, the policy has been the reverse. The management of that stadium association acts on the as-



sumption that the crowd will turn out on Thanksgiving Day and Armistice Day for any sort of attraction, and that an additional "big day" may be obtained by scheduling the best attraction on some day other than those two holidays. The results, however, have been unsatisfactory financially and the policy adopted has led to much criticism. There is some justification for this criticism. Many people in the city have not the time or opportunity to attend football games aside from holidays. They naturally feel that they are being deprived of a chance to see a game worth seeing.

Season Tickets

In large population centers the annual sale of season tickets is not important, for the stadium will be filled without them. In smaller communities every effort should be made to sell the greatest possible number in advance of the first game. Otherwise the gate receipts will be seriously affected by inclement weather.

Rain insurance should be taken out unless the seats for a game are fairly well sold out in advance.

Charges for Admission

On this point the stadium association may expect to be criticized, regardless of the policy adopted. In one city where the charges seem to be very moderate the local papers each season print letters of protest from disgruntled citizens who object to paying what they term exorbitant admission fees when the stadium was not supposed to be operated for profit. Of course these criticisms come from unthinking people who have no conception of the financial obligations that must be met. After the bonds have all been retired and the stadium becomes the property of the city, and there is no further obligation hanging over it, the charges for admission can be cut in two. However, the stadium association should adhere as far as possible to a policy of "low prices and large crowds." A crowd of 10,000 at 50 cents each is a much better asset than one of 5,000 at \$1 each.

For the present, however, the charges in that city for days other than Thanksgiving Day are 50 cents for general admission and 75 cents for reserved seats in the central section. Likewise, except on Thanksgiving Day, high school students of that city are admitted on their athletic association membership card, which costs them \$1 per year. Grade school pupils are admitted to the general section at 15 cents, except Thanksgiving Day. On Thanksgiving Day

they have their "big game" of the season with a rival high school. For this game all tickets are sold at \$1.50, except that high school and grade school pupils are admitted for 50 cents.

In another city, with about 25,000 population, the general admission is \$1 per game, and season tickets are sold at \$5 for not less than six games: High school students of that city pay 25 cents for seats in the general section. The grade school pupils of the city are admitted free, except on Thanksgiving Day. Visiting students are given a special rate of 50 cents for the general admission seats.

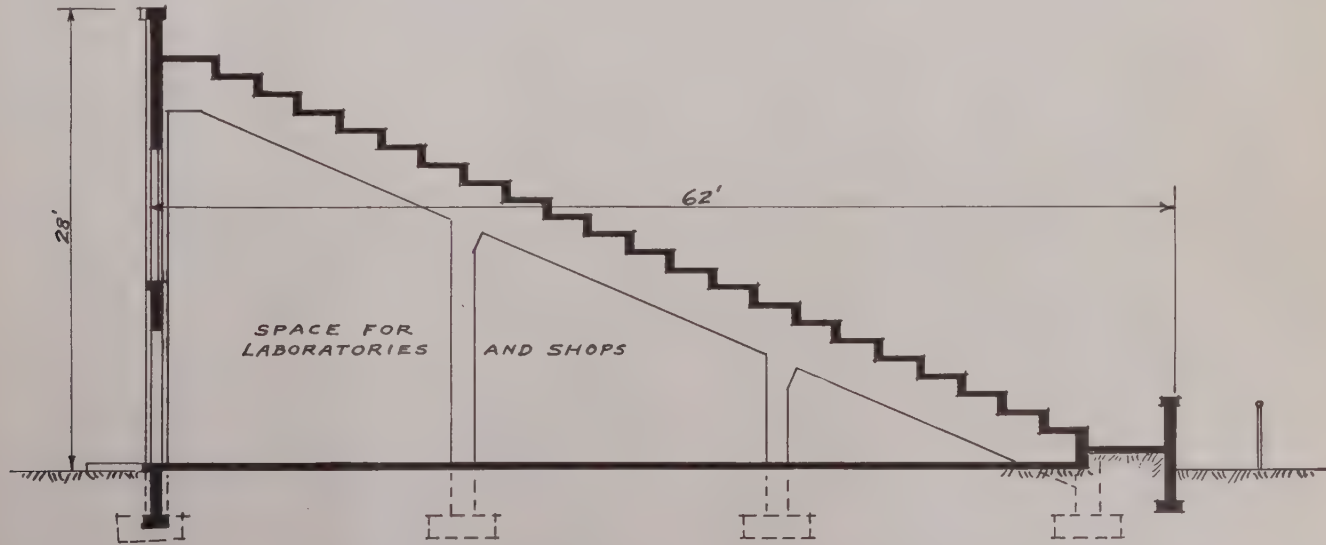
Numbering of Seats

There is a difference of opinion as to whether a width of 16 or 18 inches should be allowed per person. In one stadium individual seats were numbered at intervals of 16



A small stadium under construction. A bush-hammered finish will make it really attractive. Wood seats will be carried on the steel supports embedded in the concrete

inches, but that spacing was found to be unworkable. The numbers were then removed and replaced at intervals of 18 inches. In another city the tickets are not sold by individual seat numbers, but with reference to rows and sections. In that instance it has been found possible to obtain an average spacing of 16 inches per person. Here again the question of a fair deal to the spectators is important and should be considered. A spacing of 18 inches



CROSS-SECTION

per person, with individual seats numbered, will leave everybody in a better frame of mind and will prove the most satisfactory method in the end.

Clerical Work

Reference has previously been made to one city where the office force of the school board secretary handles all bookkeeping and other clerical work. In another city an accountant in the employ of an industrial concern takes care of the bookkeeping for the stadium association during his spare time, receiving nothing more in return than season tickets for himself and his wife.

Other Uses of Field

The athletic field may be devoted to other uses which will add to the financial return. In several cities brought to our attention the municipal stadium is used by the professional league baseball teams, as well as for boxing and wrestling matches and other events of a commercial character. The stadium may also be used for public purposes such as outdoor circuses, Fourth of July celebrations, pageants and similar events. One stadium association has made a contract with an amusement company to stage an outdoor circus and fireworks for one week each year in the month of June. While the revenue thus far received has not come up to expectations, it is nevertheless a figure that makes the undertaking worth while.

Utilizing Space Under Deck

Those responsible for the stadium project should not lose sight of the value of the space under the seat deck. In one city one of the straight sections has been completely inclosed at the rear and ends, with masonry walls. A concrete floor has been placed directly on a fill a few inches deep. The seat deck, of course, serves as a roof. The space thus inclosed is occupied by a machine shop, a wood-working shop, a tin shop, an automobile repair shop, a mechanical drawing room, a gymnasium practice room, and an instrumental music practice room. The additional cost of the inclosure was only about \$1.25 per square foot for the 16,000 square feet of floor space thus added to the school's facilities. Another stadium now under construction in a southern university will utilize the space under the seat deck as a boys' dormitory. In preliminary plans now being prepared for a stadium in one of the smaller universities, provision is being made for a much-needed engineering testing laboratory and a mechanical drafting room under the seat deck of one of the straight sections. This will provide a drafting room and laboratory 300 feet long and about 50 feet wide.

A Typical Stadium

In the accompanying illustrations we show the ground layout and a cross-section of a stadium project that might be considered as typical for a high school in a small or medium sized city, or for a college or small university. Our drawings show also the progressive construction, whereby the program to be followed contemplates construction of one straight section as a beginning. As additional funds are raised, either through sale of additional bonds or through receipts from athletic games, or perhaps from both sources, the straight section on the opposite of the athletic field will be built. This will double the first capacity, bringing the total capacity for the two straight sections to about 8,600 if seats are spaced 16 inches, or about 7,700 at a spacing of 18 inches. Finally, when additional funds are raised, the semi-circular section joining the two straight sections will be built and the stadium will be complete, with a capacity of 16,460 if seats are spaced 16 inches, or 14,800 if the spacing is 18 inches. Later

extensions, if found necessary, can be made either by extending the straight sections, at the free ends, or by removing the backwall and extending the structure in an outward direction. In either case nothing that is previously built will be wasted, aside from the removal of the back wall to its new position; but even in this instance most of the material can be used again.

Application to Colleges

What has been said regarding the municipal or high school stadium will apply, with slight modifications, to a stadium for a college or a small university. It might be necessary for the college authorities to make a direct appropriation to cover the cost of the first straight section, but from that point forward the additions should be financed largely by receipts from athletic games.

(The End)

Details of 1927 Road Builders' Convention Being Planned

Announcement has been made by the American Road Builders Association that the 1927 Convention and Road Show will be held in Chicago during Good Roads Week, January 10-14th, inclusive. The Road Show will be held in the Coliseum, as usual, but the convention and headquarters will be at the New Palmer House. Official headquarters will be opened December 10, 1926.

Two separate programs are being planned—one for engineers and officials and the other for contractors, manufacturers and material producers.

In order to increase the interest which the Association represents, a free trip to the convention and road show with all expenses paid is being offered in a contest open to all engineers and inspectors, exclusive of state highway engineers. The subject is to be a 1500-word description of a machine, material or methods used in the construction, maintenance or operation of roads or pavements.

Reduced railroad fares will be granted to all members of the American Road Builders Association and their families. The system of reduced fares to all delegates will be discontinued.

Detailed and additional information may be secured from the Business Director, Chas. M. Upham, Raleigh, North Carolina.

The Effect of Sugar on Concrete

Two recent cases of failure of concrete in districts in Egypt where sugar is very plentiful have led to the investigation of the action of sugar on cement mortar, according to recent notices in the London press. It was soon found that in the presence of sugar the concrete set very slowly and produced a mass which was very soft, containing dangerous cracks and quite unfit for service.

One case of failure was due to the weakness of one small pillar in a large concrete building in a sugar works, in which all other parts were quite sound. Now it is known that sugar combined with lime to form what is known as saccharates, and this, doubtless, was responsible for the failure.

In another case, which occurred in Copenhagen, certain portions of the structure failed to set, while the main building was excellent. In the cement, which had not properly hardened, sugar was found to be present to the extent of 2 parts per 100. This appeared to be due to the fact of the cement having been packed in sugar bags.

In general it has been proved that the presence of sugar in cement mortar destroys the resistance of the Le Chatelier test, and lowers the strength of the mortar in proportion to the amount of sugar present.

The Constitution of Portland Cement Clinker*

Part V of a Digest of Literature on the Subject—Efforts to Apply Structural Formulas to the Cement Compounds—Difficulties Encountered—Hexite-Pentite Theory—Researches of W. Asch, D. Asch, Ernest Martin, Leduc and F. W. Clarke—Much Experimentation Still Necessary

By R. H. BOGUE

THROUGH successive stages in the researches of prominent scientists, facts learned about the constitution of portland cement clinker led to the acceptance of definite theories. One of these, the Hypotheses of Solid Solution, subscribed to by many prominent authorities, was discussed in the previous chapter.

IN attempts to express the compositions of cement compounds in constitutional formulas, the investigators found themselves on comparatively unexplored ground. There was much of disagreement in the methods and the results presented.

IT was found to be extremely difficult to determine the arrangement, number and position of the various atoms in the molecular

structures of the many compounds present in portland cement clinker and the presentation of these findings in constitutional formulas was even more difficult.

MANY of the complex formulas in organic chemistry have, through exhaustive research, been developed and recorded accurately, but comparatively little has been accomplished definitely in the case of the formulas for cement compounds. Scientific facts are still needed to remove many questions from the stage of conjecture and much further experimentation is necessary.

THIS chapter presents the various attempts to express the Constitutional Formulas of Cement Compounds.

Part V.—Constitutional Formulas of Cement Compounds

W. Asch and D. Asch

IN 1911 and 1913 W. and D. Asch³⁵ published a book on "The Silicates in Chemistry and Commerce" in which they have presented a remarkable theory on the constitution of the silicates, aluminates, etc., of minerals and commercial products composed of these materials. To this theory they applied the term *Hexite-Pentite Theory*.

It seems to have been the belief of the authors that the new theory explained nearly all chemical phenomena. They attribute the classical studies of Kekule on organic structure, Erlich on side-chain structure, Guldberg and Waage on mass law, and even the laws of Newton as being, in part at least, consequences of the hexite-pentite theory. Concerning portland cement, they say:

The constitution of portland cement has been the subject of investigations for nearly a century, without any definitely satisfactory result. This is due to precisely the same cause, the persistent maintenance of a pluralistic or mixture theory and the neglect or

repression of all information or suggestions to the contrary. The attitude of many supporters of the mixture theories of portland cements is far from scientific, and notwithstanding the abundance of proof of the chemical nature in favor of the hexite-pentite theory, those in favor of a pluralistic conception of chemical substances still pin their faith to the very slender microscopical evidence on which their theories are based.

This quotation explains at the outset the attitude of the authors of the hexite-pentite theory. Visual evidence of the microscope renders perfectly obvious and undebatable the heterogeneous character of cement clinker, yet these authors set aside this type of evidence for that of an ultraspeculative form. Asch and Asch, referring to criticisms made by C. Desch and by Allen and Shepherd, say:

These critics believe that the microscopical investigations of cements has shown positively that cements are heterogeneous substances. This is the sole argument which has been brought in opposition to the hexite-pentite theory. . . . A difference in crystal form does not necessarily prove the presence of substances of different chemical composition. There is

*Paper No. 3 of the Portland Cement Association Fellowship at the Bureau of Standards.

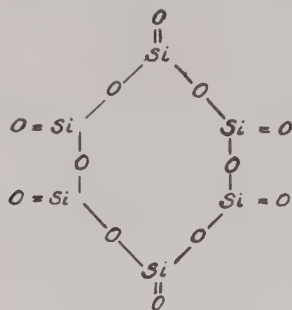
³⁵W. Asch and D. Asch, "The Silicates in Chemistry and Commerce," translated by A. B. Searle, London, 1913.

always a great probability of di- and polymorphism, whereby one and the same substance may assume different forms.

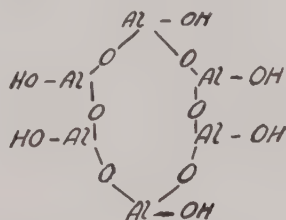
Where di-morphism occurs in a system at equilibrium, the conditions are fixed. A variation in temperature or pressure causes the disappearance of one of the phases. The authors seem not to be familiar with the abundance of evidence based on the phase rule, and supported by microscopic observation, of the non-homogeneity of lime-alumina-silica melts.

The Hexite-Pentite Theory

The hexite-pentite theory is based on the hypothesis that six molecules of $\text{Si}(\text{OH})_4$ or SiO_2 combine to form an hexagonal ring structure as, for example:



In a somewhat similar manner alumina is pictured as forming:



These are the hexite formulas. The pentite formulas are similarly produced from five molecules. The theory then consists in the assumption that all of the natural or artificial silicates and aluminates form compounds which are combinations of numerous hexite and pentite linkings, condensations, etc.

In their attempt to apply the theory to portland cements, the authors hold Fuchs responsible that

No one has hitherto regarded the portland cements as chemical compounds, as this would be in direct opposition to the view that the value of a cement lies in the (free) "soluble silica" present.

And later,

The worthlessness of these theories is particularly noticeable when an attempt is made to use them in explaining the various experimental results which have been obtained in silicate cements.

Further on they state,

When it is added that by thus regarding the portland cements as definite chemical individuals and applying the new hexite-pentite theory to them, the meaning of the whole mass of published experimental results becomes clear and that a new means of solving the important "sea-water" problem is provided, it is hardly too much to suppose that there will scarcely be a chemist who will continue to regard portland cements in the old erroneous manner as mixtures of various substances.

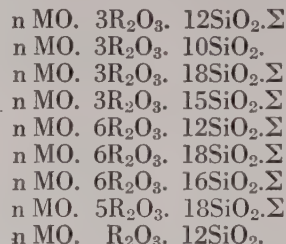
The belief of Asch and Asch on the constitution of portland cements is summed up in the statement:

Portland cements are, theoretically, highly basic lime salts of alumino silicic acids, i. e., they are basic salts of which clays are the corresponding acids.

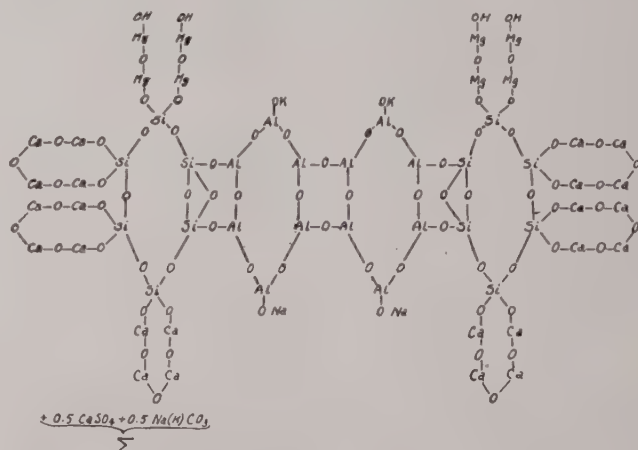
Their general properties are in entire agreement with this view of their constitution, and it is incomprehensible that on treating clay with calcium carbonate in the manufacture of cement, the product should not be a lime salt, but a mixture of various silicates and aluminates.

The Theory Applied

As a demonstration of the universal application of their new theory, the authors are ready to create a structural formula for any composition that may be revealed by chemical analysis. They present in fact forty-four empirical formulas, calculated from analysis, somewhat, as follows:



In this group n varies from 20 to 90 and Σ represents anything not considered in the formula, as SO_3 , etc. One of the actual structural formulas given as representative of portland cement is appended. This may not be regarded as the formula for portland cement, however, for according to the authors, each different composition will have a formula of its own. For the composition $2\text{H}_2\text{O}.24\text{CaO}.8\text{MgO}. \text{K}_2\text{O}. \text{Na}_2\text{O}.0.6\text{Al}_2\text{O}_3.12\text{SiO}_2 + \Sigma$, they write the formula below, and this is by no means the most complex of those offered:

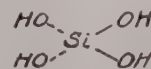


No proof of the correctness of these formulas appears to have been offered by Asch and Asch other than the ability of these authors to produce them for any composition presented by a chemical analysis.

Ernest Martin

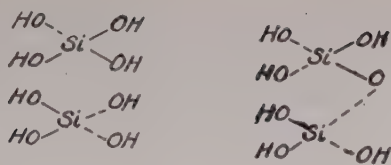
Structural formulas for many silicates and hydrated silicates believed to occur in portland cement have been proposed by Ernest Martin.³⁶ The assumptions are made at the start that (1) the normal silicic acid, $\text{Si}(\text{OH})_4$, possesses a great affinity for itself, and (2) the silicon possesses valencies which may be acidic or basic depending on the conditions surrounding it.

Thus, if the acid valencies are represented by single dashes and the basic valencies by double dashes the normal $\text{Si}(\text{OH})_4$ is expressed:



and the combination of two molecules:

³⁶Ernest Martin, "Cement," *Mon. Sci.*, 13 (1923), 173.

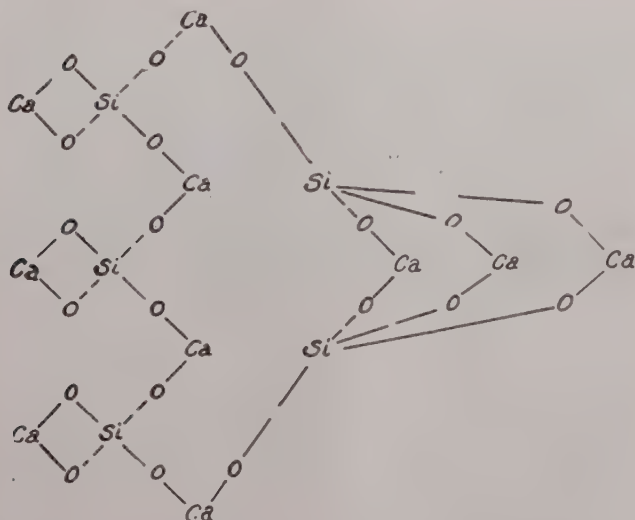


The oxygen possesses an indifferent valence, "content to transmit the valence which binds it." At high temperatures, however, "the affinity (of silica) changes completely, all the valencies become acid and they can then bind to the bases." This change in valence explains why "the silicates formed at high temperatures cease to be stable on cooling."

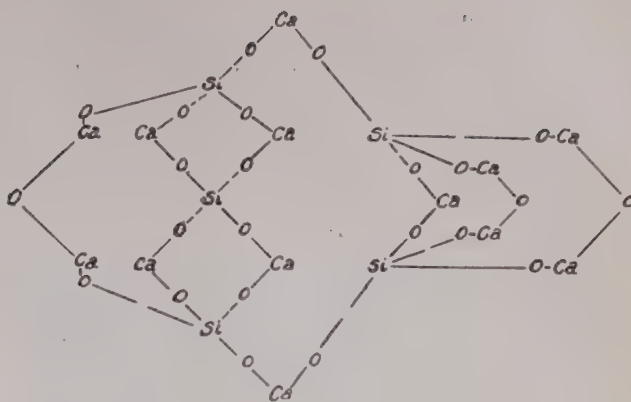
Martin then proceeds to build up a series of structural formulas intended to represent various compositions of the more or less hydrated silicic acids, and the hydrated and anhydrous calcium silicates. He assumes at all times that the water, shown by analysis to be present in various amounts depending on the method of drying or dessication, is combined within the molecule in a very definite manner, and he presents formulas which he believes indicate the special properties of each. On treatment of these hydrates with lime water, and again drying in several ways, calcium silicates in several stages of hydration are produced. The solubility of these silicates in acids or alkalis or sugar solutions, dilute or concentrated, cold or hot, is found to vary, and Martin accounts for this variation by assuming that the position of the Ca or the Si in the molecule determines this solubility. He then writes the formulas in such a manner that these structural differences are brought out. Groups in certain positions are believed to be reactive to certain treatment. Those in other positions are assumed to be unreactive. By analogy, the more complex formulas are derived.

Dicalcium Silicate

On this basis, Martin produced the dicalcium silicate, $2\text{CaO} \cdot \text{SiO}_2$, by heating CaCO_3 with SiO_2 in the correct proportion. He reported that sugar solution extracted the "free lime," that acetic acid dissolved it completely, and that solutions of Na_2CO_3 dissolved three-fifths of the silica. With this information, correlated by analogy with the silicates previously prepared, he assigns to it the formula $10\text{CaO} \cdot 5\text{SiO}_2$, which he writes:



Martin found this silicate to be nonhydraulic and therefore called it the *inactive silicate* of cement. He was unable to obtain a tricalcium silicate, and came to the conclusion that the active hydraulic compound of cements, called by him *cement silicate* is $13\text{CaO} \cdot 5\text{SiO}_2$, to which he assigned the structural formula:



Martin reported that hot solutions of Na_2CO_3 were without action on the cement silicate provided the contact was not too prolonged, while, with the inactive silicate, three-fifths of the silica was dissolved. That is, the three silicas at the left in the formula of the inactive silicate are dissolved, but in the cement silicate, due to their different position in the molecule, they are unaffected. This suggests to Martin a means for differentiating these two silicates in cement by the action of hot solutions of Na_2CO_3 . The silica dissolved by this reagent, multiplied by five-thirds, gives him the amount of inactive silicate. However, digestion for five hours with a cold solution of 20 per cent Na_2CO_3 was found to dissolve two-fifths of the silica from the cement silicate as well as three-fifths of the silica from the inactive silicate. This determination then served as a control method for determining the cement silicate.

Leduc

Martin claims also, with Leduc,³⁷ that, on heating the cement silicate to about 1000°C . for 24 hours, three molecules of CaO are liberated. He accounts for this by assuming a reaction in which the $13\text{CaO} \cdot 5\text{SiO}_2$ breaks down to $10\text{CaO} \cdot 5\text{SiO}_2$, but to this latter silicate he assigns a formula different from that assigned to the inactive silicate. This he finds necessary as he claims the new dicalcium silicate possesses some hydraulic properties, inferior, however, to those of the cement silicate.

Even a third dicalcium silicate, and also a silicate of the composition $8\text{CaO} \cdot 5\text{SiO}_2$, were reported and described as being somewhat hydraulic, but these are not believed by Martin normally to be present in clinker.

The whole question of an application of structural formulas to the natural silicates has been treated at length by F. W. Clarke³⁸ of the United States Geological Survey. He sums up the matter in the following terse manner:

Suppose now that the empirical formula of a silicate has been accurately fixed, and that a mass of data such as I have indicated are available for combination with it. Suppose the physical properties to be determined, the natural relations known, the alteration products observed, its chemical reactions and the results of fusion ascertained; what then? It still remains to combine these varied data into one expression which shall symbolize them all, and that expression will be a constitutional formula. To develop this, the established principles of chemistry must be intelligently applied, with due regard to recognized analogies. The grouping of the atoms must be in accord with other chemical knowledge; they must represent known or probable silicic acids; and any scheme which fails to take the latter consideration into

³⁷E. Leduc, "The Constitution and Formation of Portland Cement," *Bull. soc. encour. ind. natl.*, (1911), 230.

³⁸F. W. Clarke, "The Constitution of the Natural Silicates," U. S. Geol. Survey, *Bull.* 588 (1914).

account is inadmissible. Not merely composition, but function also is to be represented, and the atomic linking which leaves that disregarded may be beautiful to see but is scientifically worthless. A good formula indicates the convergence of knowledge; if it fulfills that purpose it is useful, even though it may be supplanted at some later day by an expression of still greater generality.

Difficult Formulas

The difficulties experienced by the chemist in accepting such formulas as have been presented by Asch and Asch and by Martin lie in many points. Asch and Asch have developed formulas for 17 alumino-silicic acids, having from 6 to 24 replaceable hydrogen atoms, and with molecular weights ranging from 873 to 1693. It is from such complicated acids as these, and their anhydrides, that the alumina-silicates are believed by these authors to be derived. Most of these acids have no representatives in nature and are purely hypothetical. With so many re-

placements possible, an enormous number of salts can be predicted and, as Clarke states, isomorphous mixtures, altered or impure minerals, and even bad analyses may easily be given places in the system. Clarke doubts, however, if silicates of such complexity could exist in even the coolest magma, and adds

A generalization which does too much may be worse than no generalization at all. Even for such substances as glass the authors of the hexite-pentite theory write structural formulas.

The complex formulas found in organic chemistry have been developed laboriously and each position, each type of linkage, even each stereoscopic orientation accounted for by the most searching of chemical and physical tests. But this has not been done in the case of the formulas presented in this chapter. Certain properties and analogies have indeed been studied, but there remains so much of speculation and so little of evidence that an acceptance of them is not possible without much further experimentation.

Part VI, "The Thermal Reactions of Clinker Formation," will appear in the December issue

Advanced Methods of Marine Construction

Quick-Hardening Cement Used in Construction of Amusement Pier—Concrete Pier Deck Placed on Concrete Piles—Construction Methods Described

By D. P. DE YOUNG

MARINE construction under unusual handicaps is given an excellent example in the building of the \$1,000,000 ocean amusement pier at Miami Beach, Fla. The pier, which is to be 600 feet long and of width varying from 55 to 90 feet, was placed under construction in February when the contract was let to the Frederick Snare Corporation of New York. It is expected to be completed this fall, in anticipation of the annual winter tourist season.

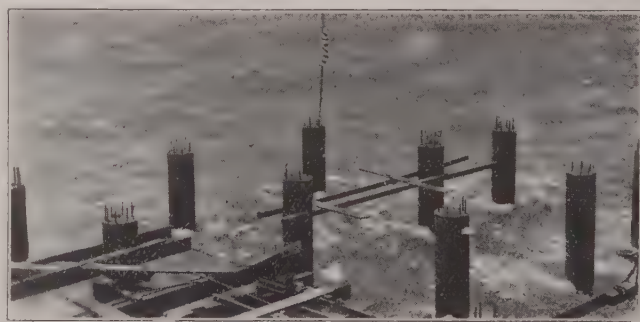
G. R. K. Carter, former real estate operator, conceived the idea of building a large ocean amusement pier on the sandy peninsula of South Florida that is Miami Beach. He dispatched Ralph A. Preas, architect, of Miami to Atlantic City to study the ocean amusement piers. Plans were drawn up along the lines recommended by the leading pier builders, and after approval were put into effect.

Following six months of activity the general contractors were able to report that they had completed the foundation, consisting of four-foot reinforced cement piling, stretching from mean low water a distance of 600 feet east, that the floorwork, of concrete 3 inches thick, reinforced by inch steel bars, had been finished, and that they were ready to proceed with the steel construction of the superstructure.

Placing Concrete Piles

Following the preparation of the grounds on the southern end of Miami Beach in February, the first shells for the concrete piling were sunk. The method of securing foundations was through the sinking of four feet caisson shells of steel through the sand to rock bottom. It was found

that the effective sealing off of such caissons would be very difficult, hence an inner shell two feet in diameter was sunk inside the outer shell after the latter had been sunk



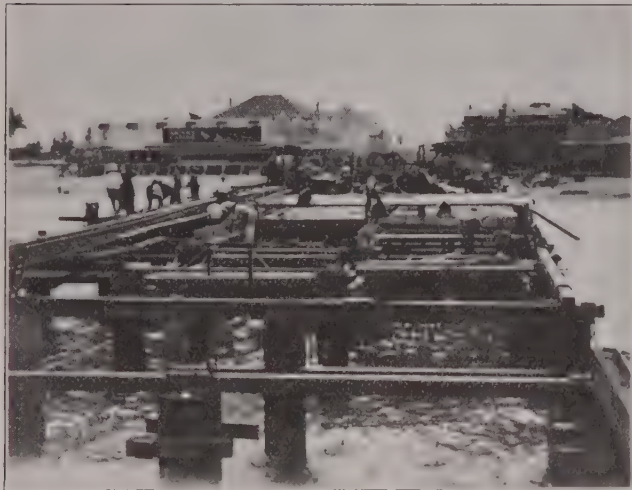
The concrete piles ready to receive the superstructure

and excavated and securely fastened to bedrock and the bottom anchorages provided by divers.

When the inner shell was in position large capacity steam syphons removed the water through the space between the two shells, keeping the water level lowered throughout the placement of the concrete in the inner shell. Lumnite cement was successfully used in this work, because of its early hardening properties which make extensive pumping operations unnecessary.

With the hardening of the concrete in the inner shell and the forming of a concrete column or pile two feet in diam-

eter to carry the floor slab and superstructure of the pier, the outer shell was removed and used over again. The plant consisted of a large traveling crane and derrick which moves out over the water on rails carried on the concrete piling as the piles are completed. With the completion of each block of four rows of piles the track and machinery were moved forward.



Placing the concrete floor

Placing Floor Slabs

When 12 rows of piles were finished concreting operations were begun on the floor slabs. The concrete framing is of the beam and girder variety framed, as is usual, with panel forms for beams and flat slabs.

With the extension of the traveling derrick out over the structure it became necessary to build a small railroad of industrial track to carry the concrete from the mixers on the shore to the point where it could be handled in buckets by the crane. The concrete buckets were of the cylindrical variety and were transported in racks on the flat cars to the point where they could be reached by the crane.

Concrete for the beam and floors was moved to place in side chute dump cars specially constructed and they de-



View of under side of the pier showing concrete piles and girders

livered the concrete directly into the forms. The heavy temporary wooden bracing between the piles served admirably to support the floor forms and allowed little deflection of the forms under load.

The superstructure of the pier will be of steel framing,

and will contain a theater seating 1,200 people, a ballroom accommodating 1,100 couples, a sea-food restaurant, cabaret, 80 concessions and stores, a fishing pier, and considerable space for outdoor advertising. Comprehensive testing has been carried on during the concrete operations, test cylinders being taken daily at the mixer. The action of the quick hardening Lumnite cement under the conditions



Anchorage for the superstructure was provided in the concrete pier floor

surrounding this project of marine work have proven to be quite satisfactory, a normal concrete strength at 28 days being secured with this cement in 24 hours.

Products Men Try Standard Cost Service

Intelligent pricing of concrete products, or any product or work for that matter, can only come through an exact knowledge of production and sales costs, plus the item of overhead. Realizing this for a fact, a group of concrete products manufacturers who have organized a live association in Minneapolis and the district surrounding that city are entering upon a program of cost-finding that will result in greater and more exact knowledge upon which to base the pricing of their products. The services of an organization that specializes in this work have been retained by the association, and individual manufacturers have likewise called upon the same organization to make individual surveys and reports.

This organization works according to three different plans. Plan "A" contemplates a lecture and survey for members of the association, and gives each member, at a minimum cost, the chance to find out the "group" cost of a concrete unit. It includes a chalk talk at the meeting, followed by a group survey and pointers on stopping any "leaks" that have been thus revealed.

Plan "B" includes two visits to a locality, the first to make a more detailed survey and the second to present the report after the data has been assembled, tabulated, and compiled into a report. A composite report is then made by the expert, illustrated by lantern slides, charts, etc.

Plan "C" includes a survey to be made by correspondence, and the delivery in person of the composite report as above. The organization is also equipped to make personal surveys of individual plants, taking anywhere between two to ten days in the plant. Another service, including the setting up of books, cost records, statements, and so on, and the issuance of monthly bulletins when a sufficient number in each state are taking advantage of the service, is to be provided.

Slip Forms Speed Work in Building Cement Plant

A Description of the Methods Used in the Construction of the New Plant of the Great Lakes Portland Cement Company at Buffalo—Slip Forms Used on Twelve of the Plant Buildings—Operation of Slip Forms Described

ONE of the interesting features in the work of building the new plant of the Great Lakes Portland Cement Company at Buffalo was the extent to which slip forms were used. Twelve of the plant structures, and these included circular storage bins and rectangular monolithic buildings, were erected by this method. The Burrell Engineering and Construction Company of Chicago were the contractors and they have developed the use of slip forms to a high degree.

The Great Lakes job consists of four main groups of buildings spread over an area of about 30 acres. The site was between a main traveled highway and the shore of Lake Erie. On one side of the new plant was a canal, permitting the shipment of materials by lake steamers.

Approximately 30,000 cubic yards of concrete are required to complete the various structures. The work included the erection of monolithic concrete silos up to 80 feet in height, reinforced concrete bins, monolithic concrete buildings and storage warehouses and heavy concrete foundations for machinery.

Aggregates

Aggregates are washed sand and gravel from Seneca Shoals in Lake Erie. They are delivered at the cement company's dock by boat and unloaded in a large storage pile adjacent to the dock. A standard gauge service track parallels the stock pile and extends from it to the mixers. Aggregates are taken from the stock pile by a Browning locomotive crane equipped with a 1 cubic yard Haywood clamshell and loaded into gondolas. The crane then con-

veys the loaded car to the mixers and unloads the aggregates into the mixer hoppers.

The boats come in with the larger particles of gravel loaded at one end and the smaller particles and sand at the other end. As the material is unloaded, the larger particles are placed in one end of the stock pile and the sand in the other. The mixer bunkers, also, are in two sections, one for fine and one for coarse particles.

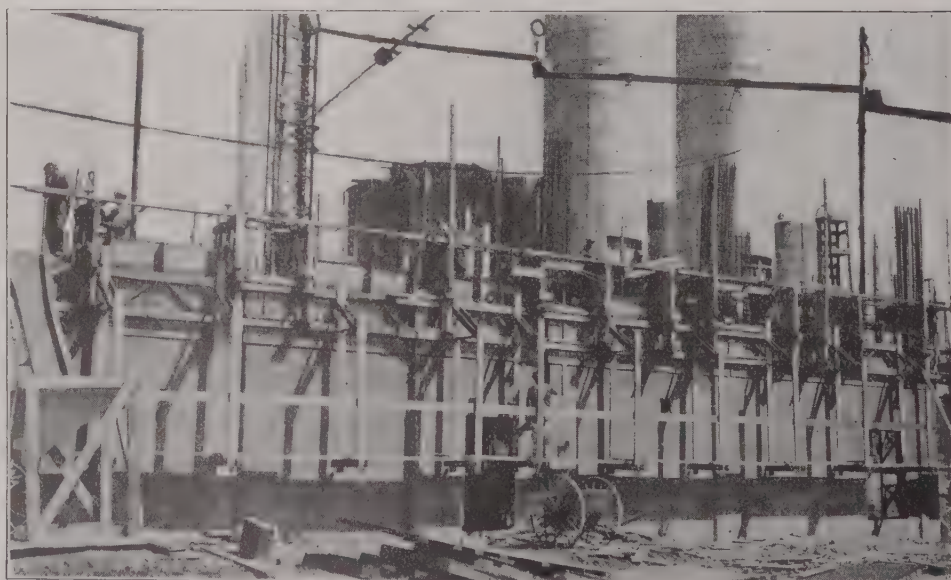
As the boats arrive at the dock, sieve analyses of the aggregates are made and the proportions are determined according to the sieve analysis results. In general, the proportions run about 1 part of cement to 4 parts of combined coarse and fine aggregates. Test cylinders on the job showed that the strength of the concrete runs about 3,000 pounds.

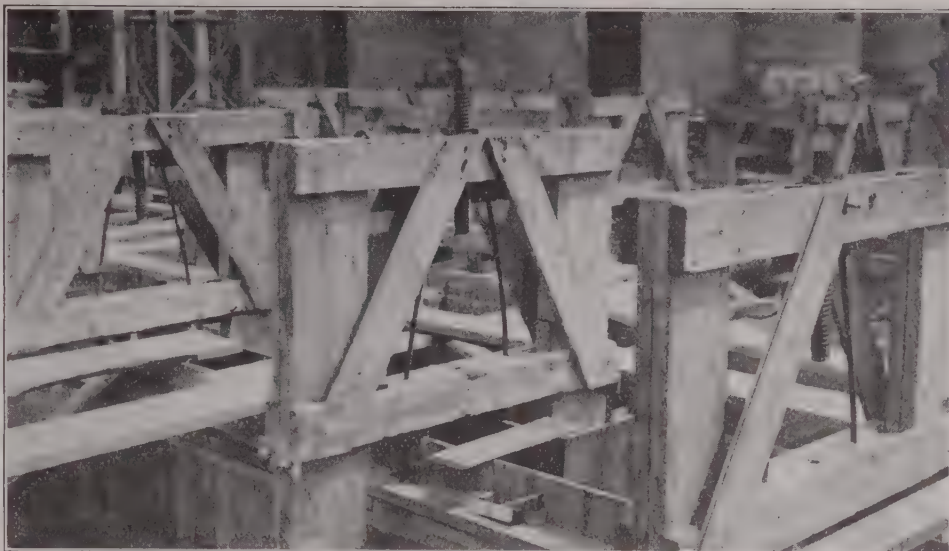
Job Layout

An accompanying sketch shows the procedure adopted by the contractor in carrying on the job. There were four mixers used, two of which were shifted to three locations as the work progressed. As previously mentioned, a standard gauge service track was laid from the stock pile to all of the mixers as shown in the sketch.

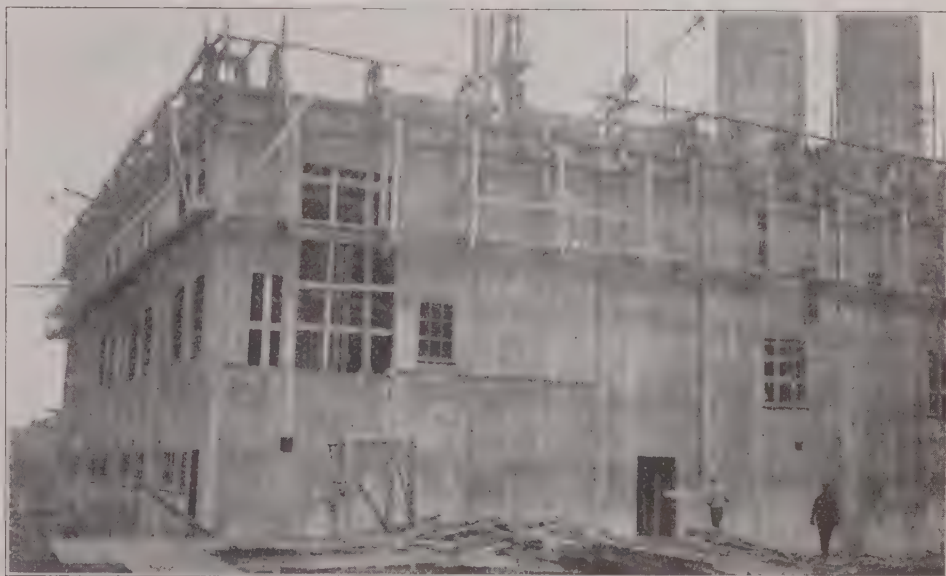
No. 1 mixer was located near the road and placed the concrete for the slurry tanks, the foundations for the kilns and coolers, the slurry storage basin, the raw and finish grinding buildings and the switchboard buildings. Mixer No. 1 is a $\frac{3}{4}$ -yard Marsh-Capron batch mixer. It placed a total of about 11,000 cubic yards of concrete from its one location.

When slip forms are used, concrete is placed continuously as the forms are slowly raised with jacks. This method results in a truly monolithic structure in which there are no joints marking the intervals between concreting operations.

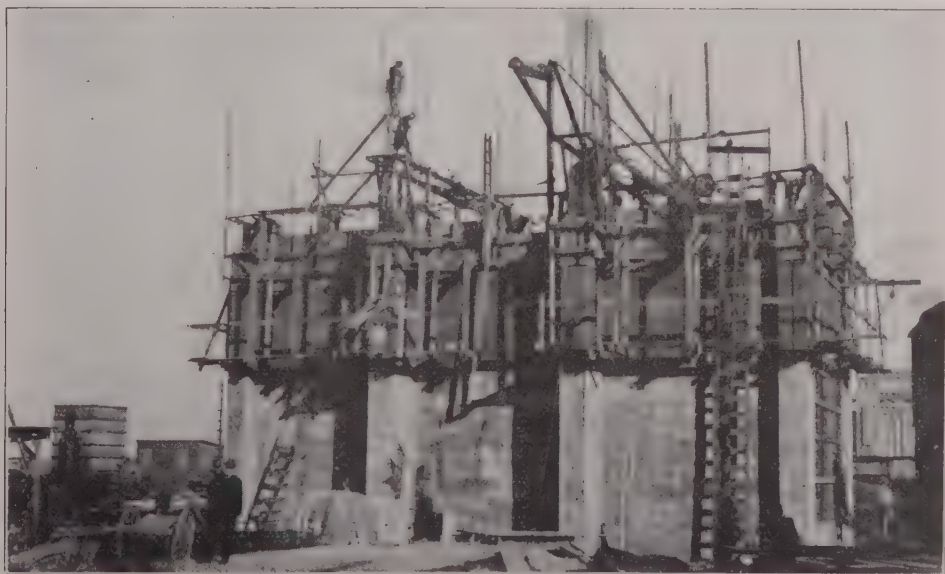




Close-up view of the wooden yokes and the jack rods. The forms are suspended from the yokes which straddle the wall. The yokes are supported on screw jacks clamped to steel rods placed at intervals inside the wall forms.



Openings for doors and windows are left in the walls as the slip forms move upward. When the top of the wall is reached the wooden working platform becomes the lower unit of the roof form.



A finishing platform is attached to the slip forms and hangs about 6 ft. below it. As the forms are raised, the finishers float the newly exposed concrete with a wood float and brush it with a soft, wet brush.

No. 2 mixer, first made the concrete for the machine shops and laboratory, then was shifted to the electric shop and transformer house and finally to the elevator building.

Mixer No. 3 also served three locations. Its first job was the 1,350 cubic yards of concrete in the wharf, then the 2,000 cubic yards in the kiln and cooler foundations and third, the storage buildings involving the placing of 5,000 cubic yards of concrete.

Mixer No. 4 placed 12,000 cubic yards of concrete from its one location. It placed the concrete for the pack houses and the monolithic concrete storage silos.

Slip Forms

Slip forms were used on the 12 buildings or groups of silos. The buildings were of varying shapes and sizes, but on all of them the slip forms proved entirely practical and economical. They were used on the following structures:

Twelve slurry tanks, each 15 ft. in diameter and 52 ft. high.

Raw grinding building, 88 ft. by 85 ft., 74 ft. high.

Finish grinding building, 132 ft. by 45 ft. by 74 ft. high.

Machine shop, 200 ft. by 50 ft. by 28 ft. high.

Transformer house, 50 ft. by 63 ft. by 33 ft. high.

Office and laboratory, 40 ft. by 45 ft. by 30 ft. high.

Change house, 28 ft. by 60 ft. by 20 ft. high.

Storage building, 260 ft. by 84 ft. by 48 ft. high.

Elevator building, 56 ft. by 29 ft. by 93 ft. high.

Sixteen storage silos, each 30 ft. in diameter and 80 ft. high.

Main pack house, 70 ft. by 81 ft. by 45 ft. high.

Truck pack house, 87 ft. by 25 ft. by 35 ft. high.

Operation of Slip Forms

Slip forms consist of wood forms placed around the entire outer and inner walls of a structure, a working platform and proper devices for suspending and raising the forms as construction progresses. Usually the form section is about 4 feet high, made of 1 by 6-inch dressed and matched lumber. The form boards for both the outside and inside are braced with 2 by 4-inch timbers so as to hold them rigidly to the true surface of the building walls. The inside and outside forms are suspended at identical elevations from wood yokes that straddle the tops of the forms. The yokes are supported on screw jacks clamped to steel rods placed at intervals of about 8 feet along the walls, between the inside and outside forms.

As the screw jacks are turned, they raise the wood forms around the entire building. Concrete is then deposited in the forms for the entire wall area, making the structure truly monolithic. There are no construction joints because of the uninterrupted placing of the concrete and the steady, continuous raising of the forms. When this method of construction is used, the work is continued day and night. Under average conditions the speed of raising the forms is from 6 to 8 feet per 24 hours, using two shifts of 10 hours each.

The wooden yokes that support the forms also support a wooden platform or decking which first acts as a working platform during the construction of the walls, and later, when it has been raised to the top of the structure, the platform is used as part of the form for pouring the concrete roof. This platform is attached to the forms and is lifted with them by the screw jacks. Holes are left in the walls for the floor, columns, beams, etc., which are poured as the forms move upward. Beams for the upper floors and the roof are poured as the platform is raised to the required height, but the floor slabs themselves are not placed until the walls are completed.

Finishing

A finishing platform is attached to the slip forms and hangs about 6 feet below it. As the forms are raised the finishers, working from the platform, float the concrete wall with a wood float and brush it with a whitewash brush dipped in water. By this method a uniform surface of very pleasing appearance is obtained.

Advantages of Slip Forms

In addition to the savings in construction costs made possible by the use of slip forms, they have some important advantages from a construction point of view. The first and most important reason is that the concrete is truly monolithic. Concrete at the bottom of the forms has been there long enough to harden sufficiently to permit the raising of the forms, while at the top of the forms it is soft so that there actually are no construction joints.

Secondly, the concrete and the reinforcing bars are always plainly visible at the moment the concrete is placed. This insures accurate spacing and placing of the reinforcement and facilitates the proper placing of the concrete.

The economies are self-evident. Savings in lumber, labor of form erection and labor of form stripping constitute an important item.

Several Important Changes on Association Staff

There have been a number of important changes in the staff of the general office of the Portland Cement Association, in Chicago, effective on October 1. Essentially, they are as follows:

C. R. Ege is now Manager, Advertising and Publications Bureau, to succeed H. C. Campbell, resigned.

G. S. Eaton is now Assistant Manager, Advertising and Publications Bureau.

W. E. Hart now Manager, Highways and Municipal Bureau.

F. R. McMillan now Manager, Structural and Technical Bureau.

T. J. Harris is now Manager, General Educational Bureau.

A few notes concerning the activities of the above gentlemen would be of interest. Mr. Ege is an associate member of the American Society of Civil Engineers, and is now president of the Highways Industries Association. He has been with the Portland Cement Association for 10 years, and manager of the Highways Bureau since 1920. Mr. Eaton has been with the association for the past six years, prior to which he was a member of the staff of the A. G. C. Originally a member of the Highways Bureau, he has lately been identified with the publicity and publications work of the association. Mr. Hart is an associate member of the American Society of Civil Engineers, and a member of the American Concrete Institute, in which organization he has been quite active. He has been with the association nine years, and served three years as District Engineer at Minneapolis, and four years as Manager of the Structural Bureau. Mr. McMillan is a member of the American Society of Civil Engineers, and has been Associate Engineer with the Research Laboratory of the association for two years, prior to which he had established himself as a consulting engineer in Minneapolis. His contributions to engineering literature are widely known, especially through the medium of the A. S. C. E. and the American Concrete Institute. Mr. Harris has been prominently identified with the advertising activities of the association for the past six years. He has had valuable newspaper experience and is identified with several organizations in the journalistic field.

Cast Stone in Seattle

How the Pacific Stone Company Is Making High Grade Cast Stone in Seattle for Use on the Large New Buildings in That City and Nearby Communities, Both for Trim and for Exterior Veneer.

By R. B. JOHNSTON

The Chamber of Commerce Building, in Seattle, built about a year ago, has an exterior of cast stone. An unusual feature of the entrance facade are two cast stone plaques set on either side of the doorway. The plaques, illustrating ancient and modern commerce of the Northwest, are simple in nature and yet effective, and match the general scheme of the plain cast stone about them.

The growing use of cast stone in this section is largely due to the Pacific Stone Company, the concern furnishing the material for the Chamber of Commerce Building. The growth of this plant has been, in turn, due to the increased market built up by the quality material produced by the company. It would therefore be of interest to see just how the Pacific Stone Company takes care of its production.

Cast stone is hardly a standardized stock material, though producers have often found it advantageous to make up and carry a stock of the type and sizes of stone frequently called for by builders and architects. Such a stock usually consists of sills and lintels for the ordinary small dwelling or other building, concrete steps, chimney caps, etc., but units for the larger work are ordinarily made to order.

The usual job, therefore, starts with drawings turned over to the plant by the architect. These drawings, in blueprint form, give the general features of the building, together with the details ordinarily supplied to the stone contractor by an architect. They serve as a guide for the stone detailers, who in turn make working drawings for the guidance of the plant in the drafting room. These

drawings, sometimes prepared to full scale in the case of intricate designs, not only give a list of the quantities and sizes of the units to be made, together with color specifications, but give the necessary working details for the modeler and the key number of each piece for the guidance of the erectors. Other charts afford any additional information that may be required in the plant and on the job.

Making the Molds

The next step is that of making the molds. For this purpose the plant is organized with three mold departments to care for the three classes of work ordinarily called for. First there is the carpenter shop where wood molds are used for the ordinary run of simpler pieces. Here the wood molds are made by experts where the sectional molds are made according to the drawings.

Designs which include figures in relief and detail that is beyond the scope of the carpenter shop are sent to the department where clay models and glue molds are made. The clay model, representing the finished piece, is first built up with great care. This is then treated in the usual manner, the plaster mold made, and then the glue poured in place. Combination molds are frequently utilized in this part of the work.

It is sometimes found that the architect has called for pieces too complicated for even this department, and the work must be entrusted to the sculptors in the third department. Here a model must be made with any of the sculptors' mediums, and the mold made from this hand-



To the left of the door is the plaque illustrating primitive industry, the activities of the Indians that originally inhabited the Northwest. The hunters are returning with the trophies of the chase, women prepare the grist with the old hand implements, artisans are designing crude implements and fashion likenesses of the people, while the history of the inhabitants is recorded on the totem pole. Man's first domesticated animals are portrayed by man's best friend—the dog. Designed by Morgan Padelford, sculptured by Mildred Strummer

carved model. The greatest of skill is required in the work, since the men must not only be experienced artists, but must be able to design a workable mold for the most intricate of work, a mold that may be used over and over again if the piece will require duplication.

The Facing Material

When the molds have been finished they are coated with shellac and are ready for use. Placed upon wooden pallets, each mold is taken to the machine. The surfacing material, mixed to the right consistency to be plastered onto the surface of the mold, is applied until the coating is at least an inch in thickness. This facing material is a mixture of cement and special aggregates to conform to the specifications of the architect. Naturally the aggregates are selected in accordance with the effect that is to be

in order to facilitate replacement in case of breakage. Wire or steel hooks have been cast in the unit for the convenience of the men on the job.

Special Designs

Not all pieces are ready for the job, however, after casting, and curing, but must return to the plant for additional sculpturing, polishing, or other operation, if hand carving or polishing are required by the architect. These two operations are handled in the same way and with the same tools as if the unit were of quarried stone. Unless such treatment is needed, however, an order can be put through and made ready for delivery within ten days of receipt. If quicker service on simple work is required, however, the process can be speeded up and work delivered within two and one-half days, although the pro-



At the right of the door the plaque typifies the modern industry of the section. Here are six male figures showing the farmer who harvests the grain, the woodsman who fells the trees of the forest, the pilot at the wheel of a vessel that denotes commerce, the fisherman who uses his nets to supply the fish of the waters, the miner who exploits the mineral resources of the Northwest, and the workman holding the sprocket of industry, typifying the manufacturing enterprise of modern life. Designed by Morgan Padel-ford, sculptured by Mildred Strummer

gained, and larger aggregate is used when the work is to be exposed to the weather than when it is for interior duty only.

As soon as this facing material has been well applied to the required thickness on the inside surface of the mold, the mold is filled with the semi-wet backing mixture, adequately reinforced with steel bars or mesh depending upon the requirements. The unit is then ready for the next operation. An electric tamping machine, striking a 400-pound blow, at the rate of 600 blows a minute, compacts the concrete in order that the mold may be immediately stripped and the curing process begun.

Curing the Work

For a period of one or two days, depending upon the weather, the unit is constantly sprayed with water, following which it is put into the steam kiln for further curing. This part of the process requires another two days, after which the unit is moved to the yard for storage and further treatment.

In the storage yard the unit is washed with a solution of muriatic acid to remove the gray cement film and expose the colored aggregates in the facing, and a waterproofing material is then brushed on if the unit is to be used for exterior work. Then, as soon as the piece has cured sufficiently it is loaded onto a truck or railroad car for delivery to the job.

Each stone is conspicuously lettered with the symbol that matches the mark assigned to that unit on the erection drawings, in order that the stone setters on the job will put the unit in its proper position in the structure, and

ducers prefer to allow at least ten days to pass before the work is delivered.

The Pacific Stone Company employs a staff of 45 men, all highly skilled in some part of the work. Such men are hard to find, because of the newness of the cast stone industry in the Northwest. The founders of the company have recently relinquished control to three men who had gained years of experience with the Benedict Stone Company, and the process used is consequently quite similar to the process used in eastern plants. One outstanding difference, however, is the fact that a drier mix than is common in the east is used in making the units.

Such has been the growth of the industry in the Northwest that the plant is assured capacity operation for some time to come, since there are a great many unfilled orders on the books. Besides the Chamber of Commerce building mentioned in this article, the company supplied the stone for the new buildings of the University of Washington and for many other interesting structures in that part of the country.

"Building Sidewalks by the Mile," is the title of a most interesting story, describing a one-course concrete sidewalk job in Northern Minnesota. It will be published in the December issue.

Tennessee Curing and Proportioning Methods

Calcium Chloride Admixture and Weighed Batches Used on Tennessee Paving—Results Obtained

By O. H. HANSARD

Engineer of Tests, Tennessee State Highway Department

TWO interesting innovations in paving practice are in use on state work in Tennessee this season. One, measuring batches of aggregate by weight, was tried out last season and found so satisfactory that it was incorporated in the specifications as an alternate proportioning method. The other, calcium chloride mixed with the concrete as a substitute for wet earth curing, was an experiment.

The project on which both these new features were used is 6.61 miles of Route 1 in Davidson County, east of Nashville. Route 1 is a very old thoroughfare. It was opened to travel on its present right-of-way during the era of national road building from 1825 to 1833. Water-bound macadam was laid on many sections at that time and has been added to, patched, and surfaced since then. Now the worn out surfacing and the macadam underneath have both been plowed up to make way for the new concrete pavement.

Although this is only one of the jobs in Tennessee on which batches are measured by weight, the equipment and procedure necessary are so new they deserve special description. At the central proportioning plant the washed river sand and crushed limestone are handled from cars to storage piles or bin by an industrial crane. One Blaw-Knox bin, with two compartments, holds both the sand and the stone. Underneath the bin there are two measuring hoppers, each hung on the levers of beam scales.



The batch hoppers were hung on the arms of a lever scale and batches were measured by weight

Gravity chutes from the sand and stone compartments deliver material to both hoppers.

Weighing the Aggregates

Each hopper holds sand and stone for one batch. One man weighs the batches. In weighing a batch, the weight on the scale beam is first set for a little less than the total

weight of sand required and the sliding valve closing the sand chute is opened wide. The operator keeps his eye on the beam and the instant it rises closes the sand chute, and sets the scale for the exact weight of the sand. Then the valve is repeatedly opened slightly and closed so that only a little sand runs into the hopper until the beam just floats and the exact weight of sand has been secured.

Then the scale is set for about 40 pounds less than the weight of the whole batch and stone is admitted rapidly until the beam rises, after which, the scale is set for the exact weight and stone is admitted a little at a time, as the sand was, until the beam floats.

The whole operation can be completed so quickly that an experienced man weighs the two batches which each truck carries while the loaded truck is pulling out from under the hoppers and an empty truck is backing into place.

Moisture Determinations

The batch weights of sand include the weight of the sand itself plus the weight of the moisture it contains. The plant inspector determines the water in the sand by selecting a sample representative of the material to be used that day and determining the loss of moisture when the sample is dried to constant weight. If he finds that the sand contains 3 per cent of moisture and a batch requires 1,000 pounds of sand, then the scaleman is told to set his scale at 1,030 pounds when weighing sand.

The sample of sand is dried over a small stove. If a large pan is used and the sand is spread thinly over the bottom, the moisture determination can be made in 20 or 30 minutes. In dry weather, one moisture determination is made per day. If there is considerable variation from the previous determination or if it has rained since the last determination was made, additional samples are tested as a check. Moisture in sand ranges from 1 to 6 per cent, averaging 3 per cent. Eighty-five per cent (85%) of all sand tested contained from 2 to 4 per cent of moisture.

There is so little moisture in the limestone that moisture determinations are not made; the weight of dry material is used.

Proportions are specified by volume. The state laboratory gives the inspector the cubic foot weights of dry material for the different kinds of aggregate. These are based on the absolute volume of each material and the per cent of voids because then the yield is constant for every grading of aggregate. For limestone, 45 per cent is used as the average voids, and, for sand, 38 per cent, requiring 1.60 barrels of cement per cubic yard of concrete in place.

Inspecting the Sand

In addition to giving the scaleman the proper batch weights, the plant inspector samples every car of sand.

Part of each sample is sent to the laboratory for a strength test; the balance is used by the inspector in making a colorimetric test and a sieve analysis. A sieve analysis and visual inspection is also made of each car of stone, to see that it conforms to the state specification for grading and general quality.

The slump is determined and a 6 by 12 inch test cylinder molded for each 500 lineal feet of pavement. These cylinders are left lying alongside the pavement for 21 days and are then sent to the laboratory to be tested in compression when 28 days old. On earth-cured concrete the cylinders are covered with earth and sprinkled as often as the slab, but on this job, where no earth covering was used, the cylinders are not covered or wetted, but receive the same treatment as the pavement.

During the first part of the job, proportions of 1:2:3½ were used. Laboratory tests indicated that with this particular sand and stone a mix of 1:1.8:3.7 would not be undersanded and the 28-day strength would be increased an average of 800 pounds per square inch without appreciably changing the cement factor. Because measuring aggregates by weight eliminates the bulking effect of sand and secures uniform batches, it is safe to proportion the sand so that the mortar is closer to the volume of voids in the stone.

Calcium Chloride Used

Except for the first 24 hours, when the pavement was kept covered with wet burlap, no covering material or wetting was resorted to for curing. Instead, 2 pounds of calcium chloride were put into the mixer drum for each sack of cement in the batch. With most cements, an increase in strength of from 2 to 4 per cent can be expected when from 2 to 4 per cent of calcium chloride (by weight of the cement) is mixed in the concrete. Calcium chloride has the property of attracting moisture to such an extent that a thin layer of it spread on the surface of pavements has often been used in lieu of wet earth curing. It was included as an admixture on this job, with the expectation that it would serve both to boost the strength and to serve as a curing agent. Its success in this dual capacity is best indicated by results.

When added to concrete materials, calcium chloride must be in solution. If it is put in dry, it will not give the desired reaction but will form a sticky ball which will wash away with the first rain, leaving a hole in the concrete. If the right amount of calcium chloride is to be used in each batch, a solution must be made which contains a definite quantity of the chemical. This solution was made in each of two barrels which were carried on the platform on the left side of the mixer. Two 100-pound sacks of calcium chloride were emptied into each barrel and enough water was added to make 50 gallons, making a solution containing 4 pounds of the chemical per gallon. Three gallons of this solution were required per six-sack batch. As it took about 15 minutes for the flakes to dissolve, the solution was used from one barrel while new solution was being made in the other.

Handling the Solution

At first the solution was put into the mixer drum by hand. That took two men, one to dip a pailful from the barrel and hand it up to another who stood on the mixer where he could empty the pail into the drum. It proved a sloppy, disagreeable job for the men and an expensive operation for the contractor; so a pump designed to measure gasoline was installed on the side of the mixer. One hose from this pump was put into a barrel of solution and the other was fastened where it would discharge into the mixer drum. Only one man was then required to operate the pump and make up the solution.

Even 2 per cent of calcium chloride makes concrete quite sticky, and at first the concrete stuck to the mixer blades, where it soon hardened. This greatly reduced the efficiency of the mixer so that it had to be shut down frequently while someone crawled inside the drum and chipped out the hardened concrete. When this trouble was experienced materials were being dumped into the skip so that the cement entered the drum first. When the coarse aggregate was put on top, where it would be discharged into the mixer first, the stones scoured the concrete from the blades and kept the drum clean.

No difficulty was experienced in finishing the concrete, but finishing operations were kept close to the mixer because concrete containing calcium chloride hardens rapidly. The pavement was not opened to traffic any sooner because of this rapid hardening except in one instance



A solution containing 4 pounds of calcium chloride per gallon was measured and pumped into the drum with a gasoline pump

where local vehicles were allowed to use the road in 10 days instead of after the usual 21-day curing period.

Other construction operations were much like those found on every concrete highway job. The concrete was finished with a machine, followed by long-handled wood floats and a thin board belt. The surface was checked twice with a straight edge, once as soon as it was finished, when any inequalities were corrected, and a second time the morning after it was placed, when any high spots were scraped off with the point of a shovel.

In some places where the subgrade is an unstable clay containing appreciable amounts of bentonite a 3- or 4-inch layer of crushed stone conforming to the specifications for waterbound macadam was put in as a sub-base.

Injurious Influences on Concrete and Their Prevention*

The Effect of Various Materials on Concrete and Steps That May Be Taken to Avoid Injury to the Structure, as Shown by Experiences and Investigations in Germany

Concrete is the hardened mixture of hydrated portland cement and aggregates. It possesses a considerable resistance against influences which cause injury to other building materials, but notwithstanding the strength and durability of concrete there are certain influences that are injurious to it and which would eventually destroy the material. The object of this article is to discuss the effect of these materials on concrete and the prevention of damage that would ordinarily result.

Upon the cement depends compressive and tensile strength, and the chemical resistance of the concrete to such things as salt water, acids, oils, and so forth, while the aggregates are relied upon to resist the attacks of crushing force, fire, and abrasion.

The aggregates ordinarily used consist of several classifications. These are natural gravel and sand, artificial crushed stone from natural stone, and artificial crushed stone from blast furnace slags, brick, cinders, etc. When these aggregates are mixed in the correct proportion between the large and small stones and coarse and fine sand, there is not much difference in the strength and durability of the concrete, whether these aggregates are hard or soft, natural or artificial.†

The Destruction of Concrete

Concrete is either destroyed by *physical* means, such as excess compression, excess tension, concussion, vibration, electricity, or fire, or it may be destroyed by *chemical* means, destroying the cohesive power of the cement by means of acids, or expansion by sulphates. Abrasion, fire, or frost are likewise destructive agencies.

The chemicals that come in contact with concrete, and many of which attack the material to some degree may be classed as solids, liquids and gases.

Fertilizers are frequently stored on a concrete floor. Among these are the *Super-phosphates*, *Chili-saltpeter*, and *Ammonium Salts*. The first type will often attack a floor, but the remedy is simple. Use any means that will harden the surface, and incidentally lengthen its life by resistance to abrasion. Any standard commercial floor hardener will be found suitable. *Chili-saltpeter*, otherwise known as *Potassium Nitrate*, does not harm concrete as long as no ammonium salts are present. *Ammonium* salts injure concrete. Among these fertilizers are *Ammonium Saltpeter* and *Nitrate of Ammonium*. It is necessary to protect a floor exposed to these products with a protective coating of some sort of asphaltic compound such as "Awa-asphalt," and this surface must be protected from abrasion by the shovels by means of a wooden top floor.

Ores containing oxygen without sulphites are not injurious to concrete, whereas the sulphuric acid in some ores may be very dangerous when water is added, as in that

case free sulphuric acid is readily formed. Under such conditions an asphaltic paint will afford the necessary protection. No protection is needed under dry-storage conditions.

Coal frequently contains a large amount of sulphur, and when water is allowed to come in contact with such coal the concrete surface will require the same protection as with ores containing sulphur. *Peat* requires much the same protective measures.

Gases and Concrete

Gases such as *Sulphuric Hydrates*, *Sulphuric Acid*, *Chlorides*, and *Carbonic Acids*, are found to be injurious to concrete. Against *Sulphuric Hydrates*, concrete should at least be protected by a suitable paint or sometimes with a layer of material that is more resistant. *Sulphuric Acid* is still more dangerous, and when this exposure is present the concrete should be made of cement that is low in lime and should be covered with some material that contains bitumen. *Chlorides* are, in the presence of water, changed to muriatic acid. This acid, in turn, destroys the concrete by changing the lime into easily soluble chloride of lime, which soon crumbles away. The remedies are a hardened surface or, in severe cases, coats of asphalt or bituminous paints. *Carbonic Acids*, in a gaseous state, do not injure concrete. When these gases, however, are dissolved in water they will cause disintegration of concrete (see section on *Water Containing Carbonic Acids*).

Liquids in Concrete Tanks

Concrete tanks are often used for holding all manner of liquids. Floors are frequently exposed to damage by liquids spilled thereon in the course of many manufacturing operations. Since many liquids have been found to injure concrete the following notes on protective measures are of interest.

The liquid organic bases and most of those that are inorganic in character are harmless to concrete. *Soda Lye* and *Potassium Lye*, frequently used in the manufacture of soap, are both harmless. *Ammonium water*, such as is used in the manufacture of gas and coke, is also harmless unless ammonium salts are produced. In the latter case a covering coat or impregnation of a material such as "Inertol,"‡ "Murolineum," or "Margalit" should be used. *Lime Water*, *Baryt Water*, *Strontium Hydroxide* or *Alkaline* waters require the use of a well-troweled surface of maximum hardness. These are the inorganic bases. The organic bases are all harmless.

The acids are generally of a more harmful nature. The inorganic acids are probably almost harmless when weak, but are very dangerous when strong. These include such acids as *Sulphuric Acid*, *Muriatic Acid* (otherwise known as *Hydrochloric Acid*), and *Nitric Acid*. The weak acids are those that are organic in nature, such as *Vinegar*, *Lac-*

*Translated and abstracted by E. Lee Heidenreich, from a series of articles written by Dr. Richard Grun, Dusseldorf, Germany, appearing in the German journal, *Zement*.

†Note—This latter statement conflicts with the findings and opinions of authorities in the United States and should be taken simply as the statement of Dr. Grun.

—THE EDITORS.

‡This and other preparations enclosed in quotation marks are European products. There are a number of equivalent materials made in the United States to be used for the same purposes.

tic Acid, Tannic Acid, and the Fruit Acids. Concrete should be protected from the weak acids by protective paints, while the strong acids demand a suitable covering by plates or linings; single, double or triple, with alternating joints. These joints must not be filled with ordinary portland cement mortar, but must be of some acid-proof clay or other resistant cementing material.

Carbonic Acid in Water

Water containing Carbonic Acid, such as seltzer water, beer, ginger ale, pop, and the so-called artesian waters, work injuriously on concrete, but very slowly. The best protection has been found to be a coat of "Inertol." As already stated, the organic acids or weak acids should have a protective coat in addition to the hard finish. This applies especially to *vinegar, lactic acid* and *tannic acid*, as is used in the tanneries.

Formaldehyde and the *fruit acids* require a protective coat in addition to the hard concrete surface. *Sugar*, likewise, requires a protective coat. *Fermenting liquids* often require, besides a protective coat, an asphalt coat, glass plates, or aluminum plates. In the latter case the aluminum must be separated from the concrete, since the free lime in the concrete is found to injure that metal. *Alcohol* and *Methyl Alcohol*, or *Methanol* do no harm to concrete.

Acid oils, fusel, and similar products are very injurious to concrete and require a protective coating of a material similar to "Murolineum," "Inertol," etc., or a special lining laid in oil-proof clay. *Phenol*, or *Carbolic Acid*, require a protective coat on the concrete, pure *Phenol* even requiring a special lining. *Oxalic Acid* is the only acid that is entirely harmless to concrete. *Wine Acids*, such as are used in the chemical industry, are very weak but require some protection such as fluatation¹ or silication².

The Inorganic Salts

The *Sulphates*, or salts of *Sulphuric Acid*, exist to a considerable extent in seawater. They are also present in the preparation of *Potash* and in a number of chemical processes. Of these salts, *Calcium Sulphate* or *Gypsum* may be quite harmful to concrete, and the concrete should therefore be carefully protected by a lining. *Sulphates of Potassium, Soda* and *Magnesium* are also injurious to concrete and require particularly hard surfaces. *Sulphate of Magnesium* is probably the most dangerous of this group of chemicals. *Sulphate of Copper, Zinc, Aluminum, Manganese, Iron, Nickel* and *Cobalt*, usually as are found in chemical factories, are nearly as injurious to concrete as the sulphate of magnesia, and as these salts are usually more or less concentrated, the only safe protection is a lining.

Sulphate of Ammonia is most injurious and destroys concrete quite rapidly when concentrated. The only safe protection is a lining laid up in acid-proof clay.

The harmless chlorides are the chlorides of *Soda, Potassium, Calcium* and *Strontium*, while the harmful chlorides are those of *Magnesium, Iron, Mercury, Copper* and *Ammonium*. Protection against the latter group of chlorides consists of the use of hard surfaces and treatment of the concrete with "Murolineum," or fluatation followed by a coating of a suitable paint.

The *Nitrate of Ammonium*, found in the fertilizer industry, is extremely harmful and must at all times be kept away from concrete. The nitrates of *Potassium, Soda* and *Calcium* are considered harmless.

With the exception of *Sulphide of Ammonia*, the soluble sulphides are considered harmless to concrete, whereas the insoluble sulphides (*Sulphur, Ores, Pyrites*, etc.) form sulphuric acid when exposed to the air, and are conse-

quently harmful. The *Carbonates* have no bad effect upon concrete. The *Fluorides* are harmless, and are even used as a protection to concrete by the fluatation process. The *Silicates* are considered harmless, and are likewise used as a protective surface, particularly the silicates of *Soda* and *Potassium* (Water glass).

The Organic Salts

Some organic salts are harmless to concrete, while others are more or less injurious. The *fats* and *fat oils* are the injurious ones, while all others are harmless and will not be mentioned. For the storage of oils or fats, the concrete surface must be as hard as possible and the cement used must contain a minimum of free lime. If the oils are heated a special lining will be found necessary, and joints in this lining must be oilproof. In less difficult cases, fluatation may be resorted to, followed by an oilproof paint covering.

Mineral Oils have much in common with fats. The products of the distillation of *Naptha* are really harmless to concrete, but penetrate rapidly into the material. The best protection here is Brandt's Method, which is a repeated fluatation, or a glazed lining. The heavy oils require no protection except a hard worked surface. This was fully proved during the war. The *coal tar* oils contain *Phenol* when in the raw state, and this must be kept away from the concrete, unless the surface is protected with such a material as "Margalit." *Colloidal* solutions are all harmless to concrete.

Miscellaneous Liquids

Inorganic liquids, such as *Mine Water, Chlorides of Lime, Gas Water, Ground Water* and *Sea Water*, all require protection by fluatation or some special coating.

Organic liquids, such as *Beer, Silage, Manure, Molasses, Sour Kraut*, and *Syrup*, require fluatation, while *Milk* and *Wine* have no injurious influences on concrete.

For the protection of concrete against injurious materials a great many materials have appeared on the market. To make a concrete surface hard and tight, fluatation is applied by a brush or spray, using a material such as water glass, and the surface is afterward covered with some bituminous product which acts as a paint. Plastering the surface with a rich mortar containing pulverized iron (Ironite) has been widely used in the United States. There are many chemicals that are mixed with the gauging water. Others are applied as a surface treatment or a paint. Special plates or linings of brick, tile, aluminum, asphalt on metal lath, glass, etc., have been tried and found satisfactory. Their uses are outlined above.

Silo Stave Men and Silo Builders to Meet in Chicago

Acting upon the request made by several silo builders and silo stave manufacturers, a meeting has been called, to be held in the Hotel Sherman, Chicago, Ill., on November 30 and December 1. Topics for discussion will include all matters relating to merchandising, manufacturing and erecting silo units and concrete silos. The first day will be devoted to general matters of interest to the manufacturers and erectors of all types of silos, to cutter manufacturers, and to accessory manufacturers. The second day will be devoted to sectional meetings of stave silo men and of monolithic silo builders, at which will be discussed matters relating to the particular methods of their own part of the industry. Several prominent authorities have arranged to address the convention, and a very worthwhile program has been devised by the convention committee.

¹Fluatation:—The application of a coat of silicofluorid to the surface.

²Silication:—Treatment with water glass, or sodium silicate.

British Specifications for Portland Cement and Concrete

The Specifications Adopted Last Year Show Greater Stringency—Finer Grinding—Higher Hydraulic Modulus—Greater Compressive Strengths—An Increase in the Amount of Permissible Magnesia—Specifications for Materials, Proportioning and Mixing of Concrete

The British standard specification for portland cement was prepared, and is periodically revised, by the British Engineering Standards Association, an organization which, although independent, is the English counterpart of the United States Bureau of Standards. The British Engineering Standards Association was formed in 1901 as the Engineering Standards Committee of the United Kingdom by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and the Institution of Electrical Engineers. The Association was incorporated in 1918, and it exists for the purpose of drawing up British standard specifications for materials, machinery, or apparatus. It does not, however, embark on such work on its own initiative, but at the specific request of an authoritative body such as a representative trade organization, a technical society, or a government department, and to fill a recognized want.

The Association is not a profit-making concern, and the only expenses it incurs are staff salaries, office expenses, and printing. In addition to grants received from the government and the amount derived from the sale of the standard specifications it publishes, it has to look to industry as a whole for the funds necessary to carry on the work.

Who Is Responsible

In order to keep abreast of the industries concerned, the B. E. S. A. specifications are subjected to periodical review. Suggestions for improvements are welcomed at all times and are accepted from outside sources. Such suggestions, upon being received, are recorded, and in due course are brought to the notice of the committees charged with the revision of the specifications to which they refer.

The following British Government Departments and scientific and industrial organizations were represented upon the sectional committee and sub-committees entrusted with the preparation of the association's standard specification for portland cement: Admiralty, War Office, India Office, H. M. Office of Works, Crown Agents for Colonies, Board of Trade, Department of Scientific and Industrial Research, London County Council, Association of Consulting Engineers, Federation of Civil Engineering Contractors, Institute of Chemistry, Institution of Structural Engineers, Imperial Institute, Railway Engineers' Association, Royal Institute of British Architects, National Federation of Building Trade Employers, Cement Makers' Federation—a very imposing auspices.

The Latest Specification

The last revision of this specification was adopted by the Sectional Committee on Cement on July 21, 1925, and

was approved on behalf of the Main Committee on September 18, 1925. It was issued to the public in October, 1925. This specification differs from its predecessor (issued in 1920). The last previous revision of the specification was carried out in 1920. Since then it has been found desirable to make certain changes to bring it more into line with the requirements of the present day and to meet prevailing conditions of manufacture and testing in hot climates. In the course of the revision the committee sought for a more precise method than that hitherto adopted for determining the consistency of the neat cement paste for the tensile and setting time tests. Extensive investigations were carried out, but no method was discovered which could be considered unquestionably more reliable and the directions of the previous editions of the specification are consequently retained in the current revision. The investigations, however, are being continued in the hope that a solution may be reached for embodiment in a future revision of the specification. The current revision differs from its immediate predecessor (1920) principally in the following particulars:

(1) A summary of the tests is given at the beginning of the specification.

(2) Provision has been made for testing in hot climates at temperatures up to 95 degrees Fahrenheit (35 degrees Centigrade). In countries where the temperature runs above 95 degrees or below 58 degrees (14.4 degrees Centigrade) special arrangements have to be made between the vendor and the purchaser unless the ranges given in the specification can be artificially produced.

Finer Grinding

(3) The cement is required to be ground more finely, the permissible residue on a 180x180 sieve being 10 per cent instead of 14 per cent. Tolerances are laid down for the number and size of wires and size of openings in sieves both for cement and for sand. The minimum size of the sieving area is now specified to be 50 square inches and the minimum depth of the sieves to be $2\frac{3}{4}$ inches.

(4) The maximum figure for the hydraulic modulus has been raised to 2.90, and the maximum amount of magnesia allowed has been raised from 3 to 4 per cent.

(5) The minimum tensile breaking strength of neat cement at seven days after gauging is increased from 450 lbs. to 600 lbs. per square inch, and that of cement and sand (briquettes) is increased to 325 lbs. The 28-day test on neat cement has been eliminated, while the minimum tensile strength of cement and sand 28 days after gauging is increased to 356 lbs.

(6) The amount of water for gauging cement and sand briquettes is now to be ascertained by means of a formula

based upon the amount needed to produce the plastic mixture required in the tensile test for neat cement.

(7) The Standard Leighton Buzzard sand is required to be of the white variety and its loss of weight on extraction with hot hydrochloric acid is not to exceed 0.25 per cent.

(8) The initial setting time of normal setting cement is to be not less than 30 minutes and the initial setting time of quick setting cement not less than five minutes.

(9) Changes have been made with regard to the Le Chatelier tests.

Opens New Deposits

Although in many respects the revised specification is somewhat more stringent than that of 1920, the increase in the maximum amount of magnesia permissible makes it possible for certain limestone deposits to be utilized for cement-making which have previously been excluded on account of their high magnesia content.

This specification defines the standard quality of cement and certain matters relative thereto, but it does not include the provisions necessary for a contract for the sale or use of cement.

The cement, says the specification, shall be manufactured by intimately mixing together calcareous and argillaceous and other silica and alumina-bearing materials, burning them at a clinkering temperature and grinding the resulting clinker so as to produce a cement capable of complying with the specification. No addition of any material shall be made after burning other than calcium sulphate, or water, or both. No cement to which slag has been added or which is a mixture of portland cement and slag will comply with the specification. The Association issues a special standard specification for portland blast furnace cement.

Test Requirements

The following summary of tests appears in the specification:

(a) Fineness. Residue on 180×180 sieve not to exceed 10 per cent and residue on 76×76 sieve not to exceed 1 per cent.

(b) Chemical Composition. (1) The hydraulic modulus (or ratio of lime to silica and alumina) to be not greater than 2.90 nor less than 2.0.

(2) Loss on ignition not to exceed 3 per cent.

(3) Insoluble Residue not to exceed 1.5 per cent.

(4) Magnesia not to exceed 4 per cent.

(5) Total Sulphur calculated as Sulphuric anhydride not to exceed 2.75 per cent.

(c) Tensile Strength. (Neat cement.) Not less than 600 lbs. per square inch (42.18 kg. per cm.²) at seven days.

(d) Tensile Strength. (Cement and Sand.) 3-1 sand cement mortar not less than 325 lbs. per square inch (22.85 kg. per cm.²) at 7 days, and 356 lbs. per square inch (25.03 kg. per cm.²) at 28 days, with diminishing increase at 28 days on a sliding scale, as per formula, if the seven days' tests are higher than 325 lbs.

(e) Setting Time.

Normal Setting Cement—Initial set of not less than 30 minutes, and final set of not more than 10 hours.

Quick Setting Cement—Initial set of not less than 5 minutes and final set of not more than 30 minutes. (The term "quick setting" cement does not necessarily imply that the cement hardens quickly.)

(f) Soundness. Expansion by the Chatelier Test not more than 10 mm. (0.40 inches) after 24 hours' aeration, or 5 mm. (0.20 inches) after seven days' aeration.

Reinforced Concrete

A British "Standard Specification for Reinforced Concrete Work" was issued by the Concrete Institute in 1920 and is still valid. This institute has since changed its name to the Institution of Structural Engineers, its scope having been widened to render this broader nomenclature necessary.

With regard to materials and workmanship, this specification provides that all materials shall be of British manufacture throughout. The following provisions are made in regard to cement:

The cement shall be obtained only from approved manufacturers and shall conform in every respect with the British Standard Specification for portland cement; quick-setting cement shall not be used without permission in writing from the architect or engineer.

The contractor shall supply free of all charge a signed certificate from the manufacturer with each consignment, stating the results of tests and recording the date of grinding and shall produce invoices for all cement received on the works.

Approval of Cement

If the certificate shows the cement to be inferior to that specified or if the architect (engineer) or his representative should have a doubt as to the cement complying with this specification, the cement may be delivered and placed in store, but it shall not be used without permission, pending investigation by the independent testing engineer aforesaid and the decision of the architect (engineer) as to whether the cement complies with the specification.

The cement shall be delivered in properly sealed bags or barrels, and no bag or barrel shall be opened until the architect (engineer) or his representative shall have inspected the seal. Each bag or barrel before being opened shall be weighed in the presence of the said representative, and shall weigh the invoiced amount in addition to the weight of the bag or barrel.

Handling on the Job

The cement shall be delivered ready for immediate use and may be used direct from the bag. The bags of cement shall be kept in a perfectly waterproof and reasonably air-tight shed, the floor of which is raised from the ground. If to be kept longer than 14 days covered bins shall be used. The cement shall be used, as far as possible, in the order in which it has been stored. The cement shall be stored on the site in such a manner as to permit of easy access for proper inspection and identification by the architect (engineer). Where cement delivered upon the site is to be used within 48 hours it may be stored on a floor raised at least 12 inches from the ground if it be covered with rainproof tarpaulins.

If required, the cement after delivery on the works shall be tested, at the owner's expense, in the following manner: Cubes mixed in the proportion of 3 parts of standard sand to 1 part of cement by weight, shall be made up and treated in all respects similarly to briquettes of sand and cement for the tensile test, but the test specimens for crushing shall be cubes of not less than 50 square centimeters per side. The crushing strength at 28 days shall be not less than ten times the tensile strength of sand and cement briquettes required by the British Standard Specification for Portland Cement.

Sand Specifications

The specification contains the following provisions regarding sand:

The sand shall be clean and gritty and composed of hard siliceous grains or other materials approved by the

architect (engineer). It shall be free from clay and any animal, vegetable, bituminous or other deleterious matter. Unless initially clean all sand shall be thoroughly cleaned by washing in flowing water.

All sand shall pass through a mesh three-sixteenths of an inch square measured in the clear. Sand shall not be used if it contains more than 10 per cent of fine grains that pass a 76-mesh sieve as used for cement-testing unless the proportion of cement be increased to the satisfaction of the architect (engineer).

The sand shall be separated from the coarse material before the materials are measured.

The Coarse Aggregate

The following demands in regard to coarse material are called for:

The coarse material shall be obtained from clean sea, river or pit gravel, or shall consist of broken hard stone, such as granite, basalt, dolomite, trap rock, hard brick or other equally hard suitable material to be approved by the architect (engineer).

The following materials shall not be used with the sand or coarse material in the composition of the concrete:

- (a) Coal residues, including clinkers, cinders, ashes, coke breeze, pan breeze, slag or other similar materials.
- (b) Blast furnace slag, copper slag, forge breeze, dross and other similar materials.
- (c) Sulphates, including plaster of Paris and other similar materials.
- (d) Broken bricks containing dust, soot and mortar refuse, or bricks from clay containing free lime or pyrites.
- (e) Limestones, magnesian limestones, marbles and other calcium carbonates—if the concrete is required to be fire-resisting.

The coarse material shall be of such size as will pass through a mesh three-quarters of an inch square measured in the clear and be retained on a three-sixteenths-inch mesh measured in the clear, and shall vary in size as much as possible within these limits.

The coarse material, if of a porous nature, shall be thoroughly wetted before being mixed with the other materials.

For sea or river work, pipes, tanks, and all structures exposed to or containing water, special care must be taken to avoid the use of stone of a porous nature.

The stipulations made regarding water are as follows:

The water used for mixing cement grout, mortar and concrete is to be provided by the contractor and shall be free from earthy, vegetables or organic matter, acids, and alkaline substances in solution or suspension. No sea or brackish water shall be used.

Proportioning the Mix

With reference to concrete proportions and mixing, the specification says:

The concrete shall be composed of cement, sand and coarse material in the proportions stated by the architect (engineer) upon the drawings, in this specification, or as ordered in writing; and the ultimate compressive resistance shall not be less than that specified for the proportion adopted:

—Proportion by Volume—			Ultimate Compressive Resistance in lbs. per sq. in.	
Cement	Sand	Coarse material	1 month or 28 days after mixing	4 months or 120 days after mixing
1	2	4	1,600	2,400
1.2	2	4	1,800	2,600
1.5	2	4	2,000	2,800
2	2	4	2,200	3,000

Cement shall be proportioned by weight. For the pur-

pose of gauging, 90 lbs. shall be deemed to be the equivalent of 1 cubic foot.

Gauge boxes shall be used for measuring the sand and coarse material in the required proportions. Such gauge boxes shall be made of wrought wood and shall be of such size and shape and shall be used in such a manner as directed by the architect (engineer) as to enable the proportions of the materials to be checked readily.

Mixing the Concrete

The concrete shall be mixed until it is of even color and even and regular consistency throughout. Mixing may be done by mechanical batch mixers or by hand. When the magnitude of the contract permits all mixing shall be done by a machine, which shall be of a design approved by the architect (engineer). The capacity and number of mixing machines provided by the contractor shall be such as to suit the requirements, in order that all concrete shall be used when freshly made so as to prevent loss of strength by premature setting. Special attention shall be devoted to this point in warm weather, when the setting of cement is considerably accelerated. Care shall be taken not to use any concrete showing signs of initial setting. The water for each batch of concrete must be measured in a small tank, so as to insure the same amount being used each time. The concrete shall be discharged from a mixer onto a water-tight platform or floor, or into a receptacle.

Hand Mixing

When permission is granted for mixing by hand, the mixing shall be done on a clean, even, close-boarded platform of adequate size, or on a hard, clean, impervious and even surface. The materials shall be mixed as follows: (1) The coarse materials shall be measured into a gauge box. (2) After the removal of the box the coarse material shall be spread to an even layer. (3) The sand gauge box shall be placed upon the layer of coarse material, filled with sand, and then removed. (4) The sand shall be spread evenly over the coarse material. (5) The requisite quantity of cement shall be spread evenly over the layers of sand and coarse material. (6) All the ingredients shall be turned over three times or more until they present an even color throughout. (7) A measured and sufficient quantity of water shall be applied from a watering-can through a perforated rose nozzle. (8) As far as possible the batches shall always be brought to the same degree of wetness. (9) After wetting, all the ingredients shall be turned over three times or more until the concrete has an even consistency throughout.

In mixing concrete by hand long-pronged rakes shall be used in addition to shovels.

For mass concrete the quantity of water added to the other constituents shall be sufficient to allow of a plastic mixture being made which, after ramming, will quiver under the rammer and exude a small amount of water on the top surface. For reinforced concrete the quantity of water added to the other constituents shall be sufficient to allow of a plastic mixture being made and tamped into all parts of the mold and between the reinforcing members.

There are numerous provisions concerning the reinforcement in reinforced concrete, and it is primarily stipulated that the steel shall be made by the open-hearth process and that re-rolled old material shall not be used.

The findings of a recent survey of a 21-year-old concrete arch bridge will be presented in the December issue.

New Equipment

Spot Welder for Concrete Pipe Reinforcing Cages

With a spot welding outfit recently placed on the market, the concrete pipe manufacturer can now make better and stronger pipe at a low cost by welding his reinforcing cages before making the pipe. The strength of the product is increased since the welded joint is able to carry as much load as the rest of the mesh, and is reported to be far stronger than the lapped joint. The machine is designed to be wheeled easily about the shop, and can thus be readily taken to the work. After the cages are formed they are quickly spot welded by the small electrodes on the water-cooled cables of the welder. These electrodes are released as soon as the weld is completed, and the process is repeated on the next lap of wire. As high as 3400 welds, or 200 cages, a day have been made in this way by two men, and rather inexperienced men at that.

Since the steel is a poorer conductor of electricity than the copper electrode, it immediately begins to heat when current is passed through. The hotter it becomes the greater becomes the resistance to the electric current. When the welding temperature is reached the current is turned



Here is the new spot welder manufactured for the concrete pipe producer by the Ohio manufacturer

on and at the same time pressure is applied to force the particles of the metal together and complete the weld. The operations of controlling the current and applying the pressure are performed automatically with the equipment described.

New Metal Column Forms Just Introduced

A new system of metal column forms that cut forming costs in two for one Washington, D. C., contractor, has just been announced by the American Rolling Mill Company of Middletown, Ohio. On one job, this contractor erected a large eight-story building with 21,000 square feet of floor space on each floor, on which 208 columns had to be formed on each story.



Here is one of the new column forms partially set up

Four carpenters handled the forms, and the work required six and one-half days to the floor. It was estimated that the forming

These welders, which will prove of unusual interest to the concrete pipe and culvert manufacturer, are manufactured by the Taylor Welder Company, of Warren, Ohio.

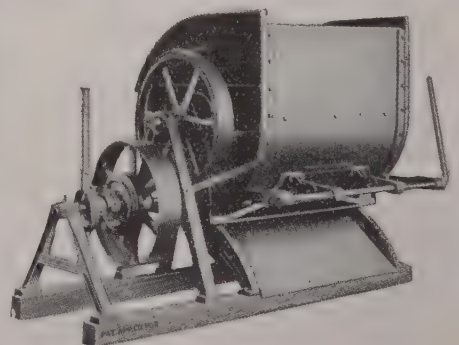
cost on these columns was less than one-half the cost of wood forms in spite of the higher first cost. Two carpenters, using hammer and nails, can make up ten to twelve columns a day, it is said.

No radical change in method is required. The column forms are said to be as easy to handle as wood and may be used over and over again for several years. Stripping is reported to be easy. The form sections are light and rigid. Channel-shaped sections of 16-gage Armco iron are furnished in two- and four-inch widths, and in three-, four-, and five-foot lengths. Each piece is punched with one-eighth-inch round holes for nailing, spaced to suit any arrangement of wood battens or cross pieces. Every section can lap one foot or less. The sections are nailed to wood battens. No bolts, wedges, or small parts are required. Occasional oiling would lengthen the life of the forms. Bent sections are said to be easy to straighten. In all, this seems to be a practical system, since its simplicity would tend to eliminate the time losses that would be incurred by a lack of simplicity. A special nail clipper has also been devised for convenience in stripping.

New 18-Ft. Mixer for Products Plants

Since its discovery that a good many products plants use the 14-foot size mixer for single bag batches leaner than the 1-3-3 mix, the *Ideal Concrete Machinery Company*, Cincinnati, Ohio, has designed an 18-foot size.

This is an oversize two-bag machine capable of taking a two-sack 1-4½-4½ mix. Particularly featured is the short drum, 48 inches long by 42 inches in diameter.



A wide face cut spur gear is used. The paddle arms are of steel castings and the blades of manganese steel. If desired, the mixer may be equipped with *Strenes* metal liners.

New Equipment

A New Automatic Tile Machine

While in Detroit a short time ago we had the pleasure of seeing the Rocktile Automatic Tile Machine in operation. The manufacturers claim that this is the last word in low production cost machines, as only one man is required to operate it and it can be timed to produce from 3,400 to 4,000 concrete tile per day. Machines have been in daily operation in different plants for over two years and are said to have given entire satisfaction.

This machine was designed and built by an engineer who, from years of practical experience, knew what was necessary in the way of operation if it were to measure up to requirements. It has been subjected to severe and exacting tests over a period of time, meeting the stringent demands made upon it.

It requires no attention other than removing the finished tile from the machine, it being completely automatic in the five necessary operations of loading, tamping, removing surplus material, lifting finished tile out of the form and returning lifting carriage to original position ready to receive another charge.

The take-off carriage removes the tile from over the mold box and places it out of the way of the operator while he drops the pallets into the mold box for the next operation. The machine works on another pair of tile while the operator is removing one part from the carriage to the conveyor.

The automatic and tamping mechanism may be stopped at any time as throw-out clutches are provided, conveniently located for the operator.

The automatic timing mechanism is entirely separate from the heavy tamping mechanism and thus removes any possibility of the tamping process interfering with

removing the side plates the entire lift may be removed from under the machine. The slides on which the tile lift operates are of hardened steel and may be easily removed by detaching two screws. The lift is forced up by a connecting rod attached to each end of the lifting frame, assuring a square and even lift on tile.

Rocktile automatic tamp lifting arms do not use a striking blow for lifting tamps,



the correct timing of the various operations.

The mold box is made up of removal plates securely locked in place, yet easily removed for changing when the side walls show wear.

The tile lift is so constructed that by

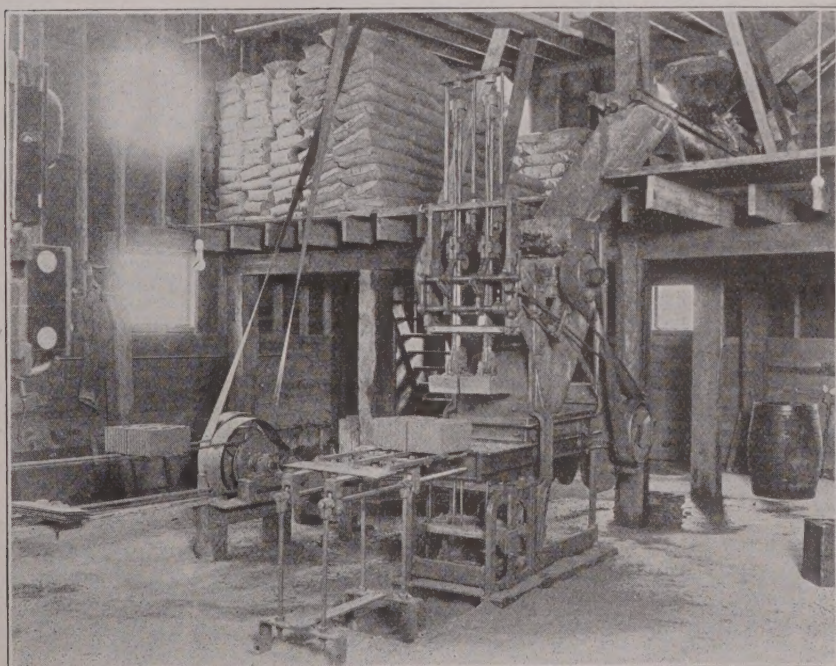
this being eliminated by using spring steel arms connected to tamps by link arms, all of which are raised by roller cams.

There is no lost motion as the machine is timed to allow sufficient time for operator to drop two pallets in the mold box while the machine is in motion, and the operator loads the finished tile on trucks for conveyors while the automatic is tamping the next pair of tile.

The operator removes the tile from the take-off carriage by sliding the carry-off plate beneath the two tile and placing them on the cable-way which conveys them to the steam room. The operator in the steam room takes the tile off in the same manner, places them on the racks, removing the carry-off plate and placing it on the lower cable, where it is returned to the machine operator.

The pallet is made of pressed steel and is very light, weighing approximately one pound. The advantage of these sheet steel pallets will be readily appreciated, eliminating, as they do, all possibility of the frequent breakage occurring with cast iron pallets.

Rocktile pallets are cheap and light, being stamped out with edges formed down. All tamping strain is taken up as the pallet is supported over the entire surface by resting on the lifting frame.





News of the Industry



Industrial Literature

The Celite Products Company Bulletin 325 gives considerable technical data on the effect of siliceous admixtures in improving the workability of concrete mixes and improving the uniformity and watertightness of the resulting concrete. A summary of tests by prominent testing laboratories on the compressive strength of plain concrete and concrete in which *Celite* was used, is also given.

In addition, this bulletin gives directions for the use of *Celite*, including the percentages recommended for various concrete mixes.

A system of coding and numbering that reduces the chances for error to 1 per cent has been introduced by the *Chain Belt Company* in a repair part and operating data book that makes the ordering of parts for the *Rex 27-E* paver an exact science. Similar books are also issued for the *Rex 3½S*, *5S*, and *14S* mixers and *21E* pavers.

A new system of code words that is practically 100 per cent proof against error in transmission is the nucleus of the new system. By certain combinations, six letters to the word, a code system is built up that will still convey the necessary information to fill an order even though only four of the letters are transmitted correctly. With the features contained in these books it is possible to enter, price and ship an order in 75 minutes or less, and in an emergency, in 10 minutes.

The pre-eminent virtues of the *Smith 27-E paver*, embracing one-man control, an easily cleaned drum, self-cleaning tractions, a timing and recording batch meter, and a half dozen others, are well described in *Catalog 409-F* of the *T. L. Smith Company*, Milwaukee, Wisconsin.

Of interest is the quick-emptying water tank, consisting of a cylindrical shell with an open top trough, pivoted inside. The trough is pivoted at both ends, to retain part of the water and allow the desired amount to run into the drum. The water enters and is drawn off through the same opening at the bottom of the tank, and cannot fill up with sediment and sand.

In keeping with its California origin, "*A Modern Construction Record*," released by the *Celite Products Company*, is a contractors' motion picture. The structural subject is a 1,750,000 bbl. reservoir involving 5100 yards of concrete. With the aid of *Celite*, the reservoir was ready to receive oil ninety days after breaking ground.

Bonding Surfaces on Concrete, is an interesting booklet showing the use of the various grades of *Con-Tex* to expose the aggregate on concrete work in order that other materials may readily be bonded thereto. This material is designed to be brushed onto the forms or on the newly-placed concrete itself. By chemical action it prevents the setting of the outer film of mortar. After twenty-four hours, or after the forms are stripped, as the case may be, the surface is washed with a stream of water from a hose, or rubbed with a wire brush, thus removing the surface film of the mortar and leaving a rough aggregate surface ready for a clean bond. The material is also available in a form for use in exposing the aggregates in stucco or in concrete products. Copies of this booklet, and others descriptive of the material, may be secured upon application to the *Concrete Surfacing Corporation*, 342 Madison Avenue, New York City.

The *Universal Farmer* is a new magazine designed for the use of helping the country dealer handling *Universal* portland cement keep his farmer customers interested in the *Universal* brand. The name of the *Universal Portland Cement Company*, by whom the magazine is published, is not to appear, but the dealer's own name will be printed on the copies that are to be distributed in his territory. The magazine, the first copy of which has just come to hand, is interestingly written from the standpoint of the farmer. It contains interesting current fiction, valuable ideas that should interest any wide-awake farmer, and matter for his wife and children. This magazine is available to all *Universal* dealers for distribution.

Voluminous testimonials commenting on the excellent qualities of *Hydro-proof* are an interesting part of the literature received from the *Asphalt Products Company, Inc.*, Syracuse, New York. *Hydro-proof* is an asphaltic, membrane-applied waterproofing in liquid form. A super-coating, *Silver Seal*, manufactured by the same firm, consists of an asphaltic base and stamped aluminum flakes.

The six-page folder, "*Small Homes of Unusual Merit*," published by the *Portland Cement Association*, contains the prize-winning concrete masonry house plans which were the victors in a contest conducted by the *Architectural Club of New Haven*. The contest opened early in 1926 to all Connecticut architects.

"Move It While You Make It" is the slogan of the *Cleveland Electric Tramrail system*, division of the *Cleveland Crane and Engineering Company*, Wickcliffe, Ohio, according to a new broadside. Deploping the practice of skilled labor lifting heavy loads and handling raw materials when it can be applied to more intelligent and productive work, the circular advocates the installation of tramrail systems to lessen the "man-power" as well as stops for changes or charging with new material, or removing the product already finished.

With the Manufacturers

The *Link-Belt Company*, Chicago, has issued a call for agents in certain territories, to sell crawler cranes and *Grizzly* loaders. An imperative qualification is a wide acquaintanceship among contractors and builders in one or more specific localities.

Communication with Laurence Spillan, at the *Link-Belt Company's* plant in Chicago, at 300 W. Pershing Road, is requested of persons qualified.

Gilbert H. Unruh has been appointed the permanent Baltimore, Md., representative of the *Link-Belt Company*, Chicago. His address for the present is 618 Register Avenue, Stoneleigh, Baltimore County, Md. (Govans P. O.)

The Birmingham office of the *American Steel & Wire Company* has been enlarged to cover all the products manufactured by the company. Mr. J. J. Gilmore, heretofore in charge, has become manager of sales, with a competent assisting force and sufficient traveling representatives to keep in close communication with the Birmingham district trade.

The *Morton C. Tuttle Company*, 862 Park Square Building, Boston, Mass., has been awarded a contract by the Manchester Traction Light & Power Company, of Manchester, New Hampshire, for the construction of a hydro-electric development on the Merrimac River at Hooksett, New Hampshire.

The work consists of repairs to 600 feet of old dam; construction of new spillway section approximately 280-foot crest; power house, 40x56; turbine installation to develop 2200 horsepower. Work will start immediately.

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Speed is a necessity on the construction job today. Delays are expensive to contractor and owner.

Continental Motors speed-up building, or any industrial operations, because they can be relied on for every working hour.

A generation of specialized experience in internal combustion engine building, a wealth of resources in men and methods, and a product designed for the purpose intended, place Continental in the forefront in the industrial power field.

CONTINENTAL MOTORS CORPORATION

Offices: Detroit, Mich., U. S. A.

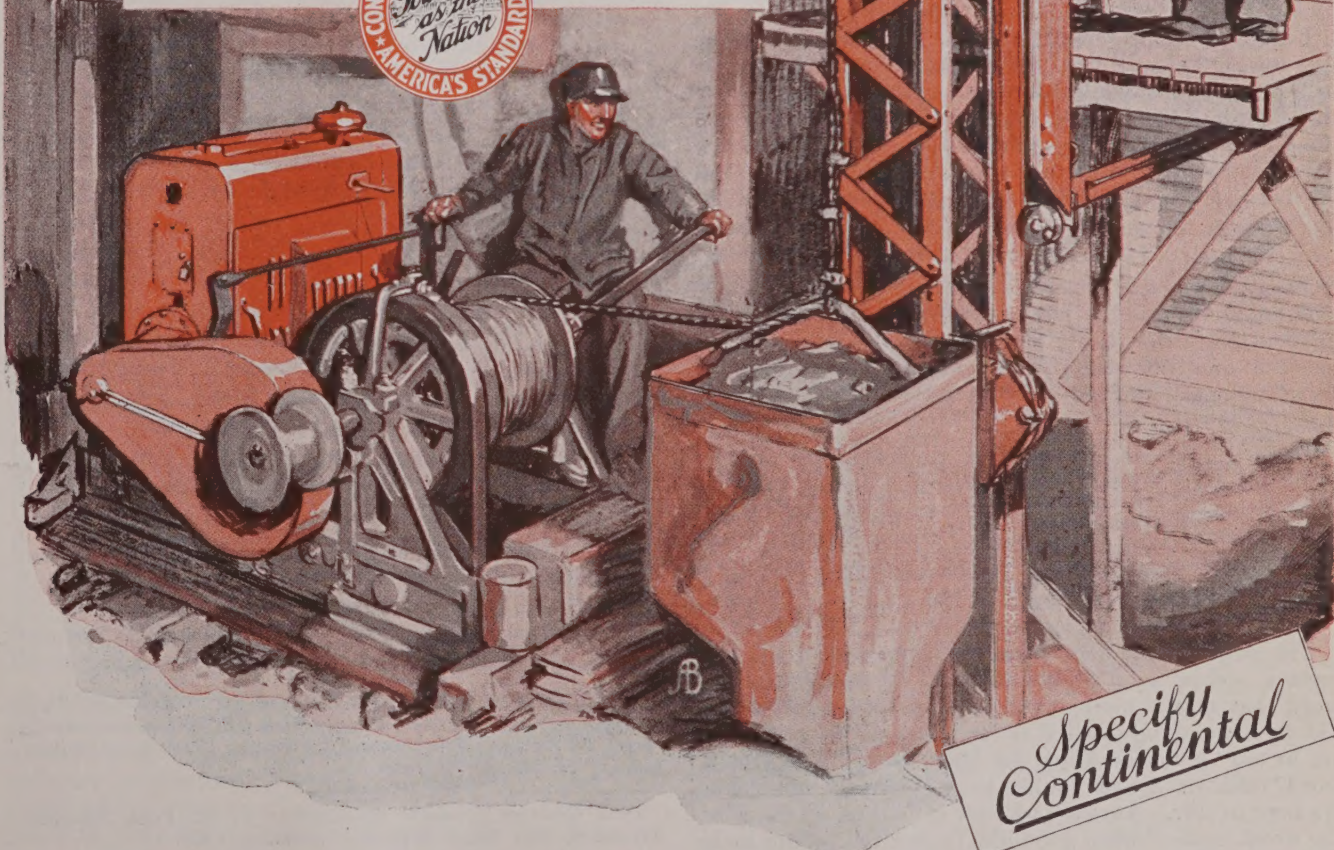
Factories: Detroit and Muskegon

The Largest Exclusive Motor Manufacturer in the World

Dependable
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For Every
Purpose



*Specify
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Continental Motors

Mixer Musings

Reported by "Joe"—The Mixer Boss.

Can You Beat It?

My old friend, Lew Healey, who runs a material yard in a town in Michigan tells me a yarn that's too good to keep from the rest of you fellows, 'cause it's one that will tickle the ribs of anyone, more so a mason. He vouches for it and gives the name of the owner and the town where it happened.

Accordin' to Lew there was a man wanted a concrete block porch built for his house, so he shopped around till he found a hasbeen who was willin' to do the work at a lower figure than anyone else in the county. He wanted beaded joints an' said so, and the so-called mason said he understood and would give him the finest job he ever saw. Then Mr. Owner went away on a trip and was gone a little while. When he came back the job was done, but when he looked it over he got the surprise of his life! Would you believe it, here was the porch built alright, but every joint was most carefully studded with marbles—mibs, we kids used to call them back in the school days. So he flivvered over to the mason's house and asked him how come. That fellow replied that he had gone up to town to get the beads for the beaded joint but couldn't find them anywhere, so he bought the marbles instead!

That's a hot one, isn't it?

Could your gang run a mix with a three-inch slump and cast it in a thin wall that would keep the water out of the cellar, not usin' any admixture or forgettin' the reinforcein' that goes into such a job? Then could you go ahead with the same mix and run up spirally-reinforced columns and get a good job? That's a poser, isn't it? Yet I saw a gang do that very thing in Chicago the other day. Try it out on the boss.

The editor of this paper has just a little while ago told how St. Louis leads in tall concrete buildin's, but to my mind it took more than a concrete mixer to win the pennant—it took old Alexander to show up the "King of Swat" an' make him fan with the rest of the bushers!

Don't it beat all the way Old Mother Nature herself swats the jerrybuilder! Where else but in the State of Subdivisions could "th' big wind" knock th' stuffin' out of the skinned jobs an' leave good concrete and concrete masonry with nothin' but a few busted windows! There's a lesson down there for all of us.

The editor of another paper sometimes read by concretors is doin' a lot of fussin' about the spelling of the word that means more than one stadium. Back in the old days we simply called it "the ball park," and folks sat in the "grandstand" or the "bleachers." The fancier word "stadium" sounds foolish to us old-timers, but maybe it's here to stay. Anyway, why try to ball us up by using the word "stadia" when good old Yankee talk would make the plural of the word read "stadiums."

How many of you fellows beat th' story Lew sent in for this month?

Joe, the Mixer Boss.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 West Thirty-ninth St., New York City.

American Road Builders' Association; Wm. H. Connell, President, Miss E. A. Birchland, Secretary, 29 W. 39th St., New York City.

American Society for Testing Materials, C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer, Secretary, 1150 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 West Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; H. E. Plummer, President, J. F. Downey, City Hall, Cambridge, Mass., Secretary.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Concrete Products Association; John E. Powers, President, Sterling, Ill.; D. R. Collins, Secretary, 47th and State Streets Alois postoffice, Milwaukee, Wis.

Iowa Concrete Products Association; H. E. Meier, President; R. L. Gavin, Secretary-Treasurer, 405 Hubbell Bldg., Des Moines, Iowa.

National Association of Building Trades Employers; A. E. Coleman, President, 37th St. & Stewart Ave., Chicago. A. W. Dickson, Executive Secretary, 214 Electric Bldg., Cleveland, Ohio.

National Association of Builders' Exchanges; William F. Chew, Baltimore, President; Earl F. Stokes, Secretary, 15 East Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East Twenty-second St., New York City.

The National Lime Association; Burton A. Ford, Secretary, 918 G Street, N. W., Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 933 Leader-News Building, Cleveland, Ohio.

National Sand and Gravel Association, V. P. Ahearn, Executive Secretary, 432 Munsey Bldg., Washington, D. C.

Nebraska Concrete Products Association; A. V. Anderson, President, Reimers-Kaufman Co., Lincoln, Neb.; E. L. Bateman, Acting Secretary, Bethany, Neb. Annual Convention, Hotel Rome, Omaha, January 27, 28, 1927.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 West Grand Ave., Chicago.

Wisconsin Concrete Products Association; A. P. Kuranz, Secretary-Treasurer, 425 E. Water St., Milwaukee.